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CHEMICAL LASER COMPUTER CODE SURVEY,(U)

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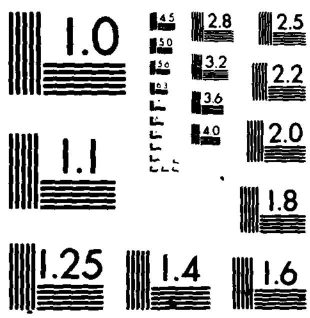

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NRL Report 8450

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Chemical Laser Computer Code Survey

LEVEL II

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Applied Optics Branch
Optical Sciences Division

December 1, 1980

NAVAL RESEARCH LABORATORY
Washington, D.C.

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A survey of modeling capability for predicting chemical laser performance has been carried out. Optics, kinetics and gasdynamics codes are included in the survey. Seventy-eight separate codes developed at thirteen research centers are covered in this report. Both quick-look summaries and more in-depth summary sheets have been prepared for each code. A supplementary narrative section provides introductory material concerning code features and capabilities as well as explanation of terminology used on the survey forms. This document is intended as a comparison of code features and as an introduction to capabilities of individual codes. Points of contact at each research establishment are
(Continues)

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20. Abstract (Continued)

provided for the reader to pursue a more comprehensive followup to this initial survey material. This report will be updated periodically as these codes evolve in capability.

CONTENTS

CHEMICAL LASER COMPUTER CODE SURVEY

Section I

INTRODUCTION

As part of its program to evaluate novel resonator concepts for high-energy laser applications, the Naval Research Laboratory (NRL) has conducted a survey sponsored by the Defense Advanced Research Projects Agency (DARPA) to determine the features and capabilities of government- and contractor-developed computer codes that model one or more features of hydrogen fluoride/deuterium fluoride chemical laser resonators. The purpose of this survey was to obtain a detailed measure of the extent of the current and near-term state-of-the-art modeling capability for predicting chemical laser performance. Because many diverse chemical laser codes exist, it was recognized that comparisons and evaluations of codes, models, and computational techniques would best be accomplished if each code architect assessed the capabilities, limitations, merits, and demerits of his own code or model for chemical laser resonator analysis and performance.

A code survey form (Appendix A) was prepared to aid in gathering information in three main areas of concern in modeling chemical lasers: optics, kinetics, and gas dynamics. It was recognized that certain codes might in some aspects be more powerful than would be required for analyzing the continuous-wave (CW), supersonic, diffusion-mixing, cold-reaction HF chemical laser. The government is interested in identifying any such extended capabilities. For this reason some generalization of the survey form in each of the three cited areas was attempted. It was also recognized that some aspects of the survey form would probably be too specific or else too general to accommodate all applicable codes and models to which they were addressed. Therefore, respondents were encouraged to cite deficiencies, make recommendations for improvements, and depart from the prescribed format when necessary to describe better the features of their codes or models.

A potential list of recipients for the chemical laser code capability survey was prepared using the following sources:

1. Attendees to the Novel Resonator Mid-Term Review held December 5 and 6, 1978, at NRL

2. Authors of papers presented at the 6th Tri-Service Chemical Laser Symposium held August 28-30, 1979, at the Air Force Weapons Laboratory

3. Attendees to the Intra-Cavity Adaptive Optics (ICAO)/Internal Focal Line Aperture (IFLA) Review held April 10, 1979, at the Air Force Weapons Laboratory

4. Distribution list for Novel Resonators for High Power Chemical Lasers Program provided by NRL.

Manuscript submitted August 6, 1980.

This list (Appendix B) includes 165 names of researchers and, in some cases, shows their current or recent areas of interest. Rather than attempt to communicate directly with this large number of potential survey recipients, it was decided instead to send several copies of the survey form to key individuals at the various companies and government agencies involved and let them make the internal distributions. This final list included 51 names and is also included in Appendix B.

A significant amount of code development, capabilities, and documentation is considered proprietary to those companies that build them. This report contains no proprietary information. The line of distinction for determining exactly which information about any code marked proprietary is vague and is best answered by the originator of the code.

The remainder of this report is a summary of the responses received from the survey. Top-level summaries and categorical distributions of chemical laser codes are presented in section II. These are intended to provide "quick-look" comparisons of code features. Detailed code capabilities and features are provided in section III.

Section II

CODE SURVEY SUMMARY

The purpose of this chapter is twofold. First, the codes are listed in various ways to aid the reader in determining where a code fits categorically among the various combinations of optics, kinetics, and gasdynamics features. Second, a single-page summary is included for each code (alphabetically by code name). The purpose of this top-level or quick-look summary is to provide a rapid evaluation of a given code's attributes and for cross comparisons before going to the more detailed level of section III.

Table II-1 provides the complete alphabetical listing of all codes included in this survey,* the company or agency that submitted them,† and their proprietary/nonproprietary status (P if proprietary)‡ An alphabetical listing of codes by company/agency, which shows also the general type or use of code (optics, kinetics, gasdynamics), is provided in Table II-2. The following rules were applied in classifying a code as O, K, or G. A code with detailed optics with up to and including a simple saturable gain model, but no detailed kinetics or gasdynamics features, was classified as an optics (O) code. A code with detailed kinetics with up to and including a simple Fabry-Perot optics model, but no detailed optics or gasdynamics, was classified as a kinetics (K) code. A code with detailed mixing or flow modeling capabilities, but without detailed optics or chemistry models, was termed a gasdynamics (G) code. In Table II-3, this categorical approach is used to divide codes into seven categories made possible by codes having different combinations of detailed optics, detailed kinetics, and detailed gasdynamics modeling capabilities. The reader will undoubtedly find many other ways to compare codes; Table II-4 provides one further example.

Some information in a very different format from that used in this survey was provided on 21 codes by Bell Aerospace Textron. Summary sheets have been included for these codes. The original Bell Aerospace inputs have been included as Appendix C.

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*Codes without names were arbitrarily given alphanumeric names for reporting consistency; such codes are indicated by a superscript asterisk following the code name.

†Most of the time, but not always, the company or agency submitting a given code was responsible for producing or building the code. Attempts have been made to properly credit the original source where known.

‡None of the information reported here is considered proprietary.

Table II-1 — Alphabetical Listing of Chemical Laser Codes

Code Name	Company/Agency	Proprietary
ABL	TRW	
AEROKNS	Rocketdyne	
AFOPTMNORO	University of Illinois	
ALCHRC*	Rocketdyne	
ALCRRC*	Rocketdyne	
ALFA	AFWL/ALC	
APACHE	AFWL/ALC	
ARM-D	Bell Aerospace	P
ARM-G	Bell Aerospace	P
BAREPL	Rocketdyne	
BCCLC*	AFWL/ALR	
BLAZER	TRW	
BLAZE I	Bell Aerospace	P
BLAZE II	Bell Aerospace	P
BLAZE III	Bell Aerospace	P
BLAZE IV	Bell Aerospace	P
BLAZE V	Bell Aerospace	P
BLAZE VI	Bell Aerospace	P
BLIST	TRW	P
CLOQ	UTRC/P&W	P
CLOQ3D	UTRC/P&W	P
CLSLGM*	SAI	
CNCDE	Bell Aerospace	P
COMOC-SA	Bell Aerospace	P
COMOC-TA	Bell Aerospace	P
COMOC-2DNS	Bell Aerospace	P
COMOC-3DPNS	Bell Aerospace	P
CROQ	TRW	P
DENTAL	AFWL/ALR	
DESALE-5	Aerospace Corporation	
DIFF-2	Bell Aerospace	P
DIFF-3	Bell Aerospace	P
ELNWD2	Aerospace Corporation	
GASSER	TRW	
GCAL	SAI	
GENRING	BDM	
GIM	AFWL/ALC/LOCKHEED	P
GLADV	TRW	P
GOAD	Bell Aerospace	P

*Indicates alphanumeric name generated for this survey.

Table II-1 — Alphabetical Listing of Chemical Laser Codes (Continued)

Code Name	Company/Agency	Proprietary
GOPWR	Rocketdyne	
GURDM	BDM	
HFGOPWR	Rocketdyne	
HFOX	Sandia Laboratories	
IPAGOS	BDM/TRW	
KBLIMP	Aerotherm Division ACUREX	
LAPU-2	LASL	
LOADPL	Rocketdyne	
LS-14RGS*	Rocketdyne	
MCLANC	TRW	P
MNORO	University of Illinois	
MPCPAGOS	BDM	
MRO	TRW	
NCFTDPWE*	LASL	
NORO-I	University of Illinois	P
NORO-II	Bell Aerospace	P
OCELOT	Hughes	P
POLRES	AFWL/ALR	
POLRESH	AFWL/ALR	
POP	Perkin-Elmer	P
PRE-WATSON	Rocketdyne	
QFHT	UTRC/P&W	P
RASCAL	Rocketdyne	P
ROPTICS	University of Illinois	P
ROTKIN	UTRC/P&W	P
SAIC2D	SAI	
SAIC2DV	SAI	
SAIFHT	SAI	
SAIGD	SAI	
SAI1D	SAI	
SAI2D	SAI	
SOS	Aerospace Corporation	
TDLCRC*	Rocketdyne	P
TDWORRC*	Rocketdyne	P
TMRO	TRW	
TWODNOZ	TRW	
URINLA2	TRW	
VIINT	TRW	
WAP*	TRW	

*Indicates alphanumeric name generated for this survey.

Table II-2 — Alphabetical Listing of Chemical Laser Codes by Company

Company/Agency	Code Name	Proprietary	Type
Aerospace Corporation	DESALE-5		K, G
	ELNWD2		O
	SOS		K
Air Force Weapons Laboratory	ALFA		K
	APACHE		K
	BCCLC		O, K
	DENTAL		O, K, G
	GIM	P	G
	POLRES		O
	POLRESH		O
BDM Corporation	GENRING		O
	GURDM		O
	IPAGOS		O
	MPCPAGOS		O
Bell Aerospace Textron	ARM-D	P	O
	ARM-G	P	O
	BLAZE I	P	G
	BLAZE II	P	G
	BLAZE III	P	K, G
	BLAZE IV	P	K, G
	BLAZE V	P	G
	BLAZE VI	P	O, K, G
	CNDE	P	G
	COMOC-SA	P	K, G
	COMOC-TA	P	K, G
	COMOC-2DNS	P	K, G
	COMOC-3DPNS	P	K, G
	DIFF-2	P	O, G
	DIFF-3	P	O, G
	GOAD	P	O
	NORO-II	P	K, G
Hughes Aircraft Company	OCELOT	P	O
University of Illinois	AFOPTMNORO		O, K
	MNORO		K
	NORO I	P	K
	ROPTICS	P	O, K
Los Alamos Scientific Laboratories	LAPU-2		O
	NCFTDPWE		O
Perkin-Elmer	POP		O

Table II-2 — Alphabetical Listing of Chemical Laser Codes by Company (Continued)

Company/Agency	Code Name	Proprietary	Type
Rocketdyne	AEROKNS		K, G
	ALCHRC		O, K, G
	ALCRRC		O, K, G
	BAREPL		O
	GOPWR		O, K, G
	HFGOPWR		O, K. G
	LOADPL		O
	LS-14RGS		O
	PRE-WATSON		O
	RASCAL	P	O, K, G
	TDLCLRC	P	O, K, G
	TDWORRC	P	O
Sandia Laboratories	HFOX		K
Science Applications, Inc.	CLSLGM		O
	GCAL		K
	SAIC2D		O
	SAIC2DV		O
	SAIFHT		O
	SAIGD		K, G
	SAI1D		O
	SAI2D		O
TRW	ABL		O, K, G
	BLAZER		O, K, G
	BLIST	P	G
	CROQ	P	O, K, G
	GASSER	P	G
	GLADV	P	G
	KBLIMP		G
	MCLANC	P	G
	MRO		O, K, G
	TMRO		O, K, G
	TWODNOZ	P	G
	URINLA2	P	O
	VIINT	P	G
	WAP	P	G
United Technologies Research Center Pratt & Whitney	CLOQ	P	O, K, G
	CLOQ3D		O, K, G
	QFHT	P	O
	ROTKIN	P	K, G

Table II-3 — Comparative Listing of Chemical Laser Codes by General Type

O, K, G*	O, K	O, G	K, G	O	K	G
ABL	AFOPTMNORO	DIFF-2	AEROKNS		ALFA	BLAZE I
ALCHRC	BCCLC	DIFF-3	BLAZE III		APACHE	BLAZE II
ALCRRC	ROPTICS		BLAZE IV	ARM-D	GCAL	BLAZE V
BLAZER			COMOC-SA	ARM-G	HFOX	BLIST
BLAZE VI			COMOC-TA	BARE PL	MNORO	CNDE
CLOQ			COMOC-2ONS	CLSLGM	NORO I	GASSER
CLOQ 3D			COMOC-30PNS	ELNWD2	SOS	GIM
CROQ			DESALE-5	GENRING		GLADV
DENTAL				GOAD		KBLIMP
GOPWR			NORO-II	GURDM		MCLANC
HFGOPWR			ROTKIN	IPAGOS		TWODNOZ
MRO			SAIGD	LAPU-2		VIINT
RASCAL				LOADPL		WAP
TDLCLRC				LS-14 RGS		
TMRO				MPCPAGOS		
				NCFTDPWE		
				OCELOT		
				POLRES		
				POLRESH		
				POP		
				PRE-WATSON		
				QFHT		
				SAIC2D		
				SAIC2DV		
				SAIFHT		
				SAI1D		
				SAI2D		
				TDWORRC		
				URINLA2		

*O = optics, K = kinetic, G = gasdynamic.

Table II-4 — Nonproprietary 2-D Codes as Functions of Basic Level of Detail and Geometry

	Company	Contact	Telephone Number
I. 2-D Wave Optics/Kinetics/Gasdynamics Codes			
Cartesian			
Blazer	TRW DSSG	Don Bullock	213-535-3484
CLOQ 3D	UTRC	Paul E. Fileger	305-840-6643
Cylindrical			
ABL	TRW DSSG	Don Bullock	213-535-3484
CLOQ 3D	UTRC		
II. 2-D Wave Optics/Kinetics			
Cartesian			
BCCLC	AFWL/ALR	Capt. Ted Salvi	505-264-0721
SAI2D	SAI	Jerry Long	404-955-2663
Cylindrical			
SAIC2D	SAI	Jerry Long	404-955-2663
SAIC2DV	SAI	Jerry Long	404-955-2663
SAIFHT	SAI	Jerry Long	404-955-2663
III. 2-D Wave Optics			
Cartesian			
CLSLGM	SAI	Robert E. Hodder	305-283-3380
Cylindrical			
BAREPL	Rocketdyne	Alexander Simonoff	213-884-3346
GURDM	BDM	Tom Ferguson	505-264-8568
LOADPL	Rocketdyne	Alexander Simonoff	213-884-3346
PRE-WATSON	Rocketdyne	Phil D. Briggs	213-884-3851
URINLA2	TRW	Don Bullock	213-535-3484

CODE SUMMARY SHEET **CODE NAME:** ABL

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162 One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models cylindrical lasers used with URINLA2. This is a URINLA2 model with gain. (See URINLA2)

AVAILABLE DOCUMENTATION: Annular Laser Mode Studies Final Report. Program ABL User Manual, June 1978.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	● Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D ● 2 D	● 1 D ● 2 D ● 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations Deformable Mirrors ● Far Field Performance Other	Single Line ● Multiline ● Line Broadening ● Other	Laminar Flow Turbulent Flow Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** AEROKNS

ORIGINATOR/KEY CONTACT:

Name: Jim Vieceli Phone: (213) 884-3851

Organization: Rockwell International-Rocketdyne Division

Address: 6633 Canoga Ave., Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Computation of small signal gain or loaded gain from a radially flowing system for use by annular resonator codes. Package includes aerodynamics for radial flow field. (Used in LS-14 study, see ALCHRC).

AVAILABLE DOCUMENTATION: Annular Laser Optics Study Final Report (AFWL-TR-77-117); Annular Laser Optics Study User's Manual: Loaded Cavity Codes.

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	●	None Simple Fabry Perot Detailed Resonator	●	None Simple Saturated Gain Detailed Kinetics (●)	●	None Simple Flow Model Detailed Mixing (●)
TYPE		Geometrical Physical	●	CW (●) Pulsed HF, DF (●) Other (●)	●	Premixed Scheduled Mixing (●) Other
GEOMETRY		Standing Wave Ring Compact Annular	●	Annular, Radially Flowing (●) Transversely Flowing Other	●	Cylindrical, Radially Flowing (●) Rectangular, Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D	●	1 D (●) 2 D 3 D	●	1 D (●) 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other	●	Cartesian Cylindrical (●) Other	●	Cartesian Cylindrical (●) Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	●	Single Line Multiline (●) Line Broadening (●) Other	●	Laminar Flow Turbulent Flow Boundary Layer (●) Shocks Other (●)

CODE SUMMARY SHEET **CODE NAME:** AFOPTMNORO

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman/T. Salvi (AFWL) Phone: (217) 333-1834

Organization: Univ. of Illinois, Dept. of Aeronautical & Astronautical Eng.

Address: Urbana, Illinois 61801

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Predict power spectral performance of CW chemical lasers by coupling an AFWL strip mirror optics code to a rotational nonequilibrium kinetics - fluid dynamics model (MNORO). Combined model is called AFOPTMNORO.

AVAILABLE DOCUMENTATION: "An Efficient Rotational Nonequilibrium Model of a CW Chemical Laser," L. H. Sentman & W. Brandkamp, TR AAE 79-5, UILU Eng 79-0505, July 1979. "Users Guide for Programs MNORO and AFOPTMNORO," L. H. Sentman, AAE TR 79-7, UILU Eng 79-0507, October 1979.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None ● Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF, DF Other	Premixed Scheduled Mixing ● Other
GEOMETRY	● Standing Wave Ring ● Compact Annular	Annular, Radially Flowing ● Transversely Flowing Other	Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line ● Multiline ● Line Broadening ● Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** ALCHRC*

ORIGINATOR. KEY CONTACT:

Name: Phil Briggs Phone: (213) 884-3851

Organization: Rockwell International-Rocketdyne Division

Address: 6833 Canoga Ave., Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: LS-14 resonator parameter selection, assess mode control, performance predictions for power extraction and beam quality, set/verify design requirements. Analysis of general HSURIA with reflaxicon. Kinetics and gasdynamics modeled by AEROKNS developed under ALOS program. See AEROKNS.

AVAILABLE DOCUMENTATION: Various.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF DF ● Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	● Annular Radially Flowing Transversely Flowing Other	● Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors ● Far Field Performance ● Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

*Axisymmetric Loaded Cavity HSURIA Resonator Code.

CODE SUMMARY SHEET **CODE NAME:** ALCRRC*

ORIGINATOR/KEY CONTACT:

Name: Phil D. Briggs Phone: (213) 884-3851

Organization: Rockewell International-Rocketdyne Division

Address: 6633 Canoga Ave., Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Ring resonator parameter selection, assess mode control, performance prediction for power and beam quality, set/verify design requirements. Kinetics and mixing models included - see AEROKNS.

AVAILABLE DOCUMENTATION: Various.

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None		None
		Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator	●	Detailed Kinetics	●	Detailed Mixing
TYPE		Geometrical	●	CW		Premixed
	●	Physical		Pulsed	●	Scheduled Mixing
			●	HF DF		Other
			●	Other		
GEOMETRY		Standing Wave	●	Annular Radially Flowing	●	Cylindrical Radially Flowing
	●	Ring		Transversely Flowing		Rectangular Linearly Flowing
	●	Compact		Other		Other
	●	Annular				
GRID DIMENSION		(Transverse Dimension)	●	1 D	●	1 D
	●	1 D		2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM		Cartesian		Cartesian		Cartesian
	●	Cylindrical	●	Cylindrical	●	Cylindrical
		Other		Other		Other
FEATURES MODELED		Misalignments		Single Line		Laminar Flow
	●	Aberrations	●	Multiline		Turbulent Flow
		Deformable Mirrors	●	Line Broadening	●	Boundary Layer
	●	Far Field Performance		Other		Shocks
	●	Other			●	Other

*Axisymmetric Loaded Cavity Ring Resonator Code.

CODE SUMMARY SHEET

CODE NAME: ALFA

ORIGINATOR/KEY CONTACT:

Name: N. L. Rapagnani Phone: (505) 844-9836

Organization: Air Force Weapons Laboratory

Address: AFWL/ARAC, Kirtland AFB, New Mexico 87117

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models any chemically pumped mixing laser system including electronic transition types; contains Fabry Perot optics model.

AVAILABLE DOCUMENTATION: ALFA, AFWL-TR-78-19

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None ● Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	● Geometrical Physical	● CW ● Pulsed ● HF DF ● Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	1 D ● 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	● Cartesian ● Cylindrical Other	● Cartesian ● Cylindrical Other	● Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	● Single Line ● Multiline ● Line Broadening ● Other	● Laminar Flow ● Turbulent Flow ● Boundary Layer ● Shocks Other

CODE SUMMARY SHEET **CODE NAME:** APACHE

ORIGINATOR/KEY CONTACT:

Name: N. L. Rapagnani **Phone:** (505) 844-9836

Organization: Air Force Weapons Laboratory

Address: AFWL/ARAC, Kirtland AFB, New Mexico 87117

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models any chemically pumped mixing laser system including electronic transition type. APACHE is the same as ALFA except that it is time dependent. Contains Fabry-Perot optics.

AVAILABLE DOCUMENTATION: APACHE, LASL-LA-7427

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None ● Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	● Geometrical Physical	● CW ● Pulsed ● HF DF ● Other	Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular Radially Flowing Transversely Flowing Other	● Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	1 D ● 2 D 3 D	1 D ● 2 D ● 3 D, Psuedo
COORDINATE SYSTEM	● Cartesian ● Cylindrical Other	● Cartesian ● Cylindrical Other	● Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	● Single Line ● Multiline ● Line Broadening ● Other	● Laminar Flow ● Turbulent Flow ● Boundary Layer ● Shocks ● Other Recirculating

CODE SUMMARY SHEET **CODE NAME:** ARM-D

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Resonator analysis codes. Models HSURIA and ring resonators. Uses strip propagator (r,z) in annular leg and (r, Θ, z) propagator in compact leg. (See appendix C, table 2).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF DF ● Other	● Premixed ● Scheduled Mixing ● Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	● Annular Radially Flowing Transversely Flowing Other	● Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D ● 2 D	1 D 2 D 3 D	1 D ● 2 D Quasi 2D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations ● Deformable Mirrors ● Far Field Performance Other	Single Line ● Multiline Line Broadening Other	● Laminar Flow ● Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** ARM-G

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Resonator analysis codes. Geometric optics code models HSURIA (with waxicons and reflaxicons) and ring resonators. Same capability as ACCOS-V except can be run interactively. (See appendix C, table 2).

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE	● 	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	● ● ● ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	 ● 	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	● ● 	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** BAREPL

ORIGINATOR/KEY CONTACT:

Name: Alexander M. Simonoff Phone: (213) 884-3346

Organization: Rocketdyne Division, Rockwell International

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: The code was designed to model a half-symmetric unstable resonator with an internal axicon (HSURIA). Performance predictions for beam quality and mode loss difference, set/verify design requirements.

AVAILABLE DOCUMENTATION: 3-D Bare Cavity Resonator Code (theory and user manual).

CATEGORY / ATTRIBUTE	OPTICS		KINETICS		GASDYNAMICS	
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	 ●	None Simple Saturated Gain Detailed Kinetics	●	None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	● ● ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	 ●	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	● ● ●	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** BCCLC*

ORIGINATOR/KEY CONTACT:

Name: Capt. Ted Salvi **Phone:** (505) 844-0721

Organization: Air Force Weapons Laboratory

Address: AFWL/ALR, Kirtland ARB, New Mexico 87115

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models lasers with conventional unstable resonators with round, elliptical, or rectangular apertures. Contains CO_2 GDL kinetics and shock wave phase sheets.

AVAILABLE DOCUMENTATION: None

ATTRIBUTE \ CATEGORY	OPTICS		KINETICS		GASDYNAMICS	
LEVEL		None		None		None
		Simple Fabry Perot		Simple Saturated Gain	●	Simple Flow Model
	●	Detailed Resonator	●	Detailed Kinetics		Detailed Mixing
TYPE		Geometrical	●	CW		Premixed
	●	Physical		Pulsed		Scheduled Mixing
				HF, DF		Other
			●	Other		
GEOMETRY	●	Standing Wave		Annular, Radially Flowing		Cylindrical, Radially Flowing
		Ring	●	Transversely Flowing		Rectangular, Linearly Flowing
	●	Compact		Other		Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
		1 D		2 D		2 D
	●	2 D	●	3 D		3 D
COORDINATE SYSTEM	●	Cartesian	●	Cartesian		Cartesian
		Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments	●	Single Line		Laminar Flow
	●	Aberrations		Multiline		Turbulent Flow
		Deformable Mirrors	●	Line Broadening		Boundary Layer
	●	Far-Field Performance		Other	●	Shocks
	●	Other				Other

*Baumgardner Cartesian coordinate laser code

CODE SUMMARY SHEET **CODE NAME:** BLAZER

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models the optical performance of linear bank CW HF and DF chemical lasers. BLASER is a 3-D model. Used as design tools for BDL, NACL, MIRACL.

AVAILABLE DOCUMENTATION: The BLAZER and MRO Codes, TRW, June 1978 (theory). BLAZER User Manual (includes use of MRO), TRW, November 1978.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact Annular	Annular, Radially Flowing ● Transversely Flowing Other	Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D ● 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations Deformable Mirrors ● Far-Field Performance Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** BLAZE I

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: 1-0 fluid code with general chemistry and no optics. Combustor and cavity analysis. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF, DF Other	●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** BLAZE II

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Detailed mixing code with general chemistry and Fabry-Perot optics. Combustor analysis and cavity analysis. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None		None
	●	Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
		Detailed Resonator		Detailed Kinetics	●	Detailed Mixing
TYPE		Geometrical		CW	●	Premixed
		Physical		Pulsed	●	Scheduled Mixing
				HF, DF	●	Other
				Other		
GEOMETRY		Standing Wave		Annular, Radially Flowing	●	Cylindrical, Radially Flowing
		Ring		Transversely Flowing	●	Rectangular, Linearly Flowing
		Compact		Other		Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D	●	1 D
		1 D		2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM		Cartesian		Cartesian		Cartesian
		Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED		Misalignments		Single Line	●	Laminar Flow
		Aberrations		Multiline	●	Turbulent Flow
		Deformable Mirrors		Line Broadening		Boundary Layer
		Far-Field Performance		Other		Shocks
		Other				Other

CODE SUMMARY SHEET | **CODE NAME:** BLAZE III

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: 2-D mixing code with general chemistry. Combustor nozzle, cavity, diffuser, and ejectors analysis. No optics. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	● 	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics	 ●	None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF, DF Other	 ●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	 ● 	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other	● ● ● 	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** BLAZE IV

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: 2-D mixing code with general chemistry. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow ● Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** BLAZE V

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: 2-D mixing finite difference code used for nozzle, fluid, and thermal analysis. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow Turbulent Flow ● Boundary Layer Shocks Other

CODE SUMMARY SHEET

CODE NAME: BLAZE VI

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

3-D optics and mixing code using finite difference, FFT, and rotational nonequilibrium models for optics and fluid analysis. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY	OPTICS		KINETICS		GASDYNAMICS	
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF, DF Other	 ●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular Radially Flowing Transversely Flowing Other		Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	 ●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other	● ● 	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** BLIST

ORIGINATOR/KEY CONTACT:

Name: R. Hughes/D. Haflinger/H. W. Behrens Phone (213) 536-2757

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: BLIST (Boundary Layer Integral Solution Technique) calculates nonsimilar development of 2-D or axisymmetric compressible laminar boundary layers with wall heat transfer.

AVAILABLE DOCUMENTATION: Internal Report: "A Description of the Laminar Integral Boundary Layer Model," TRW Report, August 1977.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	None ● Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical ● Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow Turbulent Flow ● Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** CLOQ

ORIGINATOR/KEY CONTACT:

Name: Paul E. Fileger Phone: (305) 840-6643
Organization: United Technologies Research Center
Address: P.O. Box 2691, MX-R48, West Palm Beach, Florida 33402

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

The CLOQ code was developed to analyze linear chemical laser systems using rotational nonequilibrium kinetics.

AVAILABLE DOCUMENTATION: R. J. Hall, "Rotational Nonequilibrium and Line-Selected Operation in CW DF Chemical Lasers," IEEE JQE, Vol QE-12, p 453 (1976)

ATTRIBUTE \ CATEGORY	OPTICS		KINETICS		GASDYNAMICS	
LEVEL		None		None		None
		Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator	●	Detailed Kinetics	●	Detailed Mixing
TYPE		Geometrical	●	CW		Premixed
	●	Physical		Pulsed	●	Scheduled Mixing
			●	HF, DF		Other
				Other		
GEOMETRY	●	Standing Wave	●	Annular, Radially Flowing	●	Cylindrical, Radially Flowing
	●	Ring	●	Transversely Flowing	●	Rectangular, Linearly Flowing
	●	Compact		Other		Other
	●	Annular				
GRID DIMENSION		(Transverse Dimension)	●	1 D	●	1 D
	●	1 D		2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM	●	Cartesian	●	Cartesian	●	Cartesian
		Cylindrical		Cylindrical	●	Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments	●	Single Line	●	Laminar Flow
	●	Aberrations	●	Multiline	●	Turbulent Flow
	●	Deformable Mirrors	●	Line Broadening		Boundary Layer
	●	Far-Field Performance		Other		Shocks
	●	Other			●	Other

CODE SUMMARY SHEET **CODE NAME:** CL003D

ORIGINATOR/KEY CONTACT:

Name: Paul E. Fileger **Phone:** (305) 840-6643

Organization: United Technologies Research Center

Address: P.O. Box 2691, MS-R-48, West Palm Beach, Florida 33402

PRINCIPAL PURPOSE AND APPLICATION OF CODE: CLOQ3D is an input scheduled code for analyzing HEL chemical lasers using wave optics coupled to rotational nonequilibrium kinetics or to equilibrium kinetics (HF or DF).

AVAILABLE DOCUMENTATION: User's manual to be published in February 1980.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	● Annular, Radially Flowing ● Transversely Flowing Other	● Cylindrical Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	● 1 D ● 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian ● Cylindrical ● Other	● Cartesian ● Cylindrical Other	● Cartesian ● Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations ● Deformable Mirrors ● Far-Field Performance ● Other	● Single Line ● Multiline ● Line Broadening ● Other	● Laminar Flow ● Turbulent Flow Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** CLSLGM*

ORIGINATOR/KEY CONTACT:

Name: Peter R. Carlson/Robert E. Hodder **Phone** (305) 283-3380

Organization: Science Applications Inc.

Address: 201 SW Monterey Rd., Suite 30, Stuart, Florida 33494

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Assess optical performance of MIRACL device before, during, and after acceptance testing. Essentially same theory/formalism developed by Sziklas and Siegman for the Pratt & Whitney SOQ codes.

AVAILABLE DOCUMENTATION: "Chemical-Laser Scaling - Law Gain Model Analysis," P. Carlson and R. Hodder, SAI Technical Memorandum to D. Finkleman and J. Stregack (September 25, 1979).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact Annular	Annular Radially Flowing ● Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D ● 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments ● Aberrations Deformable Mirrors ● Far Field Performance ● Other	● Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

*Chemical-Laser Scaling - Law Gain Model

CODE SUMMARY SHEET **CODE NAME:** CNCDE

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny **Phone:** (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

1-D flow analysis code analysis of combustor, nozzle, cavity, diffuser and ejectors. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF DF Other	●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET

CODE NAME: COMOC-SA

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

2-D finite element code for the structural analysis of combustor, nozzle and optics. (See appendix C, table 1.)

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** COMOC-TA

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

2-D thermal analysis (finite element) code used to analyze combustor, nozzle, and optics. (See appendix C, table 1.)

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF DF Other		Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** COMOC-2DNS

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: 2-D finite element mixing code with simple chemistry used for cavity and diffuser/ejector analysis (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow ● Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** COMOC-3DPNS

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

3-D mixing code, finite element with simple chemistry used for combustor and cavity analysis (See appendix C, table 1.)

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY	OPTICS		KINETICS		GASDYNAMICS	
LEVEL	●	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics	 ●	None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF, DF Other	 ●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	 ●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other	● ● ● ●	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** CROQ

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162 One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Models HSURIA and ring resonator with mode rotation. Intended to be a resonator design code for maximizing focusability and power of output beam as a function of gain generator and resonator parameters.

AVAILABLE DOCUMENTATION: Planned. Annual Laser Model Studies (final report for axicon theory, aligned and misaligned).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	● Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D ● 2 D	● 1 D ● 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations Deformable Mirrors ● Far Field Performance ● Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks ● Other

CODE SUMMARY SHEET

CODE NAME: DENTAL

ORIGINATOR/KEY CONTACT:

Name: Captain Ted Salvi **Phone:** (505) 844-0721

Organization: Air Force Weapons Laboratory

Address: AFWL/ALR, Kirtland AFB, New Mexico 87115

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Laser kinetics calculations with strip unstable resonator. Can select CO_2, HF/DF, or KrF kinetics.

AVAILABLE DOCUMENTATION: None

ATTRIBUTE \ CATEGORY	OPTICS		KINETICS		GASDYNAMICS	
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	 ●	None Simple Saturated Gain Detailed Kinetics	 ● 	None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical	● ● ● ●	CW Pulsed HF, DF Other	● 	Premixed Scheduled Mixing Other
GEOMETRY	● ● 	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other	 ● 	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ● 	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	● 	1 D 2 D 3 D
COORDINATE SYSTEM	 ● 	Cartesian Cylindrical Other		Cartesian Cylindrical Other	● 	Cartesian Cylindrical Other
FEATURES MODELED	● ● ● ●	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	● 	Single Line Multiline Line Broadening Other	● ●	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** DESALE-5

ORIGINATOR/KEY CONTACT:

Name: M. Epstein Phone: (213) 648-6861

Organization: Aerophysics Laboratory, The Aerospace Corporation

Address: P.O. Box 92957, Los Angeles, California 90009

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Calculation of CW and pulsed chemical laser performance.

AVAILABLE DOCUMENTATION: DESALE-5: A Comprehensive Scheduled Mixing Model for CW Chemical Laser, M. Epstein, Aerospace Corporation Report SAMSO-TR-79-31, May 1, 1979. User Manual, SAMSO TR-75-60, W. D. Adams, et al, February 20, 1975.

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None		None
	●	Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
		Detailed Resonator	●	Detailed Kinetics	●	Detailed Mixing
TYPE	●	Geometrical	●	CW		Premixed
		Physical	●	Pulsed	●	Scheduled Mixing
			●	HF, DF		Other
			●	Other		
GEOMETRY		Standing Wave		Annular, Radially Flowing	●	Cylindrical, Radially Flowing
		Ring		Transversely Flowing	●	Rectangular Linearly Flowing
		Compact		Other	●	Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D	●	1 D
		1 D		2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM	●	Cartesian	●	Cartesian	●	Cartesian
		Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED		Misalignments	●	Single Line	●	Laminar Flow
		Aberrations	●	Multiline	●	Turbulent Flow
		Deformable Mirrors	●	Line Broadening	●	Boundary Layer
		Far-Field Performance	●	Other		Shocks
		Other			●	Other

CODE SUMMARY SHEET **CODE NAME:** DIFF-2

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny **Phone:** (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

2-D unstable resonator optics coupled to mixing model. Optics uses FFT. Used to analyze optics. (See appendix C, table 1.)

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF, DF Other	 ●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	 ●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other	● ●	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET

CODE NAME: DIFF-3

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone: (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Same as DIFF-2 except 3-D mixing. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE	OPTICS		KINETICS		GASDYNAMICS	
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics	 ●	None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF, DF Other	 ●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	 ●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other	● ●	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** ELNWD2

ORIGINATOR/KEY CONTACT:

Name: John Ellinwood Phone: (213) 648-7391

Organization: The Aerospace Corporation

Address: P.O. Box 92957, Los Angeles, California 90009

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Computer transverse eigenmodes of bare annular resonators. Simple gain model to be added.

AVAILABLE DOCUMENTATION: None

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	●	None Simple Saturated Gain Detailed Kinetics	●	None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	 ●	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET | **CODE NAME:** GASSER

ORIGINATOR/KEY CONTACT:

Name: D. Haflinger/P. Lohn | Phone: (213) 536-1624

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Inviscid flow code using the method of characteristics and accounts for heat release. It is used for cavity flows with heat release defining shroud contours flow conditions at end of cavity, etc.

AVAILABLE DOCUMENTATION: None

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	● Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks ● Other

CODE SUMMARY SHEET | **CODE NAME:** GCAL

ORIGINATOR/KEY CONTACT:

Name: Kerry E. Patterson | Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: To provide extremely efficient single-line gain algorithm which is anchored to available data base for nozzle being studied. Used with SAIGD.

AVAILABLE DOCUMENTATION: HF Laser Subsystem Technology Assessment (DARPA Interim Report), Science Applications, Atlanta, Georgia, July 1979, Section 3.

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL	●	None		None	●	None
		Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
		Detailed Resonator	●	Detailed Kinetics		Detailed Mixing
TYPE		Geometrical	●	CW		Premixed
		Physical		Pulsed		Scheduled Mixing
			●	HF DF		Other
				Other		
GEOMETRY		Standing Wave	●	Annular Radially Flowing		Cylindrical Radially Flowing
		Ring	●	Transversely Flowing		Rectangular Linearly Flowing
		Compact		Other		Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
		1 D	●	2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM		Cartesian	●	Cartesian		Cartesian
		Cylindrical	●	Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED		Misalignments	●	Single Line		Laminar Flow
		Aberrations		Multiline		Turbulent Flow
		Deformable Mirrors	●	Line Broadening		Boundary Layer
		Far-Field Performance		Other		Shocks
		Other				Other

CODE SUMMARY SHEET

CODE NAME: GENRING

ORIGINATOR KEY CONTACT:

Name: Carl M. Wiggins Phone: (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road, S.E., Albuquerque, New Mexico 87106

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models ring resonators utilizing pairs of linear and nonlinear axicons (reflaxicons, waxicons) to produce an annular gain region. Used in ring resonator candidate trade-off studies, effects of spatial filtering on mode control, and to study concept of (scraper) aperture self-imaging.

AVAILABLE DOCUMENTATION: GENRING: a computer code for Modeling Cylindrical Unstable Ring Resonators With Internal Reflecting Axicons, BDM/TAC-79-152-TR, The BDM Corporation, May 1, 1979.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave ● Ring ● Compact ● Annular	Annular, Radial / Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors ● Far Field Performance ● Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** GIM

ORIGINATOR KEY CONTACT:

Name: D. W. Lankford Phone (505) 844 -9836

Organization: Air Force Weapons Laboratory

Address: AFWL/ARAC, Kirtland AFB, New Mexico 87117

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Laser cavity and nozzle analysis. Will eventually combine multidimensional viscous diffusing, time-dependent flows with the chemical kinetics capabilities of ALFA and APACHE codes.

AVAILABLE DOCUMENTATION: To become available.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	● Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	● 1 D ● 2 D ● 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	● Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow ● Turbulent Flow ● Boundary Layer ● Shocks ● Other Recirculating

CODE SUMMARY SHEET **CODE NAME:** GLADV

ORIGINATOR/KEY CONTACT:

Name: R. Hughes/D. Haflinger/H. W. Behrens Phone (213) 536-2757

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

General laser analysis to calculate average flow properties in nozzle and in cavity.

AVAILABLE DOCUMENTATION: None

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	None Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed ● HF DF Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening ● Other	● Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** GOAD

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny **Phone:** (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Resonator analysis code. (See appendix C, table 2).

AVAILABLE DOCUMENTATION:

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None Simple Fabry Perot Detailed Resonator	●	None Simple Saturated Gain Detailed Kinetics	●	None Simple Flow Model Detailed Mixing
TYPE	●	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	 ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	 ●	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	 ●	Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** GOPWR

ORIGINATOR/KEY CONTACT:

Name: Tien Tsai Yang/J. K. Hunting Phone: (213) 884-3346

Organization: Rockwell International/Rocketdyne Division

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Predict optical performance of CW chemical lasers, identify physical parameters affecting power extraction efficiency and gain saturation. (Also see HFGOPWR).

AVAILABLE DOCUMENTATION: GOPWR: A Computational Program to Calculate the Performance of CW Chemical Lasers, AFWL-TR-79-142.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	● Geometrical Physical	CW Pulsed ● HF DF ● Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	● Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	● Cartesian Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance ● Other	● Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** GURDM

ORIGINATOR/KEY CONTACT:

Name: T. R. Ferguson and G. T. Worth Phone (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road, S.E., Albuquerque, New Mexico 87106

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Originally designed to model Pratt & Whitney's intercavity adaptive optics experiments. Models base cavity compact beam resonators with circular and mirrors and one or two internal deformable mirrors. A far-field code includes external deformable mirror, tilt removal, optimim focus, etc.

AVAILABLE DOCUMENTATION: General Unstable Resonator with Deformable Mirrors (Program GURDM), T. R. Ferguson, et al; The BDM Corporation, BDM/TAC-79-193-TR, March 31, 1979.

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	 ●	None Simple Saturated Gain Detailed Kinetics	●	None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF DF Other		Premixed Scheduled Mixing Other
GEOMETRY	● ● 	Standing Wave Ring Compact Annular		Annular Radially Flowing Transversely Flowing Other		Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	 ● 	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	● ● ● ● ●	Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** HFGOPWR

ORIGINATOR/KEY CONTACT:

Name: J. K. Hunting/T. T. Yang Phone: (213) 884-2370

Organization: Rockwell International - Rocketdyne Division

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Calculational tool to study the performance of CW chemical lasers and the interaction with the gain medium. Uses geometric optics and quasi-1-D aerokinetics to model HSURIA resonator. Also see GOPWR.

AVAILABLE DOCUMENTATION: Rocketdyne Internal Letter G-SL-77-509, October 5, 1977 (theory); Rocketdyne Internal Letter G-0-78-937, January 24, 1978 (user manual).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	● Geometrical Physical	CW Pulsed ● HF DF ● Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance ● Other	● Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

CODE SUMMARY SHEET

CODE NAME: HFOX

ORIGINATOR/KEY CONTACT:

Name: James B. Moreno Phone: (505) 264-4259

Organization: 4212, Laser Projects Division, Sandia Laboratories

Address: Kirtland AFB, New Mexico 87117

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Predict oscillator and amplifier performance for Sandia Laboratories hydrogen flouride fusion laser program.

AVAILABLE DOCUMENTATION: AIAA paper 75-36, presented at AIAA 13th Aerospace Sciences Meeting, Pasadena, California, January 20, 1975. J. B. Moreno, author.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	CW ● Pulsed ● HF, DF Other	Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening ● Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** IPAGOS

ORIGINATOR/KEY CONTACT: *

Name: D. N. Mansell **Phone:** (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road, S.E., Albuquerque, New Mexico 87106

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Geometric ray trace analysis of general optical systems; can model nonlinear beam compactors of reflaxicon, waxicon, and noneverting waxicon designs.

AVAILABLE DOCUMENTATION: POLYPAGOS, Aerospace Report TR-0059 (6311)-1. Beam Compactor Design and Fabrication Program AFWL-TR-78-77. Geometric Ray Analyses of HSURIA Prototypes, BDM/TAC-79-151-TR; POLYPAGOS Users' Manual, Aerospace TR-0172 (2311)-1.

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	● 	None Simple Saturated Gain Detailed Kinetics	● 	None Simple Flow Model Detailed Mixing
TYPE	● 	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	● ● ● ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	● 	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	● ●	Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

*Also: Kemp, TRW, One Space Park, Redondo Beach, California.

CODE SUMMARY SHEET **CODE NAME:** KBLIMP

ORIGINATOR/KEY CONTACT:

Name: H. Tong/A. C. Buckingham/H. L. Morse Phone: (415) 964-3200

Organization: Aerotherm Division of ACUREX

Address: Mountain View, California

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Boundary layer analysis. Nonequilibrium chemistry (KINETIC) Boundary Layer Integral Matrix Program (KBLIMP).

AVAILABLE DOCUMENTATION: Nonequilibrium Chemistry Boundary Layer Integral Matrix Procedure, Aerotherm Report, UM7367, July 1973.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF DF ● Other	Premixed ● Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing ● Other	● Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D ● 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical ● Other	● Cartesian ● Cylindrical ● Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow ● Turbulent Flow ● Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** LAPU-2

ORIGINATOR/KEY CONTACT:

Name: John C. Goldstein, D. O. Dickman **Phone:** (505) 667-7281

Organization: Los Alamos Scientific Laboratory

Address: Group X-1, MX-531, LASL, Los Alamos, New Mexico 87545

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Calculation of the propagation of a short pulse down a chain of laser amplifiers and absorbers including diffraction effects; cylindrical symmetry assumed.

AVAILABLE DOCUMENTATION: LAPU2: A Laser Pulse Propagation Code with Diffraction, LASL Report LA-6955.

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	 ●	None Simple Saturated Gain Detailed Kinetics	●	None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical	 ● ●	CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	 ● ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	 ●	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	 ● ●	Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** LOADPL

ORIGINATOR/KEY CONTACT:

Name: Alexander M. Simonoff Phone: (213) 884-3346

Organization: Rocketdyne Division, Rockwell International

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: The purpose of this code is to model some of the 3-D phenomenology associated with Half Symmetric Unstable Resonator with Internal Axicon (HSURIA) with a radially flowing gain medium, performance predictions for power extraction and beam quality, set/verify design requirements.

AVAILABLE DOCUMENTATION: Simplified 3-D loaded cavity resonator code, G-0-78-1123, November 1978. Also see bare cavity code BAREPL.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain ● Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations ● Deformable Mirrors ● Far Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** LS-14RGS*

ORIGINATOR/KEY CONTACT:

Name: Victor L. Gamiz Phone: (213) 884-3346

Organization: Rocketdyne, Laser Optics

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Performs an exact ray trace analysis in order to determine the geometric configuration of a HSURIA type resonator with a ray redistributing reflaxicon beam compactor assembly. Provides geometry data to wave optics HSURIA codes.

AVAILABLE DOCUMENTATION: Resonator Geometry Synthesis Code Requirement (V. L. Gamiz); Incorporate General Resonator into Ray Trace Code (W. H. Southwell); Surface Optimization Algorithms and Equations (W. H. Southwell); Equations for Wave Optics Code Parameters (V. L. Gamiz); User Manual; Resonator Geometry Synthesis Code Development (L. R. Stidham).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	● Geometrical Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring ● Compact ● Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance ● Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

*LS-14 Resonator Geometry Synthesizer

CODE SUMMARY SHEET **CODE NAME:** MCLANC

ORIGINATOR/KEY CONTACT:

Name: R. Hughes/H. W. Behrens Phone (213) 536-1624

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Direct simulation Monte Carlo laser analysis code. Models real gas flow by tracking several thousand simulated molecules. Primarily used for modeling nozzle flows with large base regions and low pressure regions in hypersonic wedge wakes.

AVAILABLE DOCUMENTATION:

"Chemical Lazer Nozzle and Cavity Calculation by the Direct Simulation Monte Carlo Method," T. Sugimura, et. al, presented at AIAA Conference on High Power Lasers, October 31-November 2, 1978, Cambridge, Massachusetts.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	● CW Pulsed ● HF DF ● Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular Radially Flowing Transversely Flowing ● Other	● Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D ● 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow ● Boundary Layer ● Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** MNORO

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman Phone: (217) 333-1834

Organization: University of Illinois, Dept. of Aeronautical & Astronautical Eng.

Address: Urbana, Illinois 61801

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Rotational nonequilibrium kinetics - fluid dynamics model. Used with AFWL strip mirror code to predict power spectral performance of CW chemical lasers.

AVAILABLE DOCUMENTATION: "An Efficient Rotational Nonequilibrium Model of a CW Chemical Laser," L. H. Sentman and W. Brandkamp, TR AAE 79-5, UILU Eng. 79-0505, July 1979. "Users' Guide for Programs MNORO and AFOPTMNORO," L. H. Sentman, AAE TR-79-7, UILU Eng. 79-0507, October 1979.

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None ● Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None ● Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	● CW Pulsed ● HF, DF Other	Premixed Scheduled Mixing ● Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing ● Transversely Flowing Other	Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening ● Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

CODE SUMMARY SHEET

CODE NAME: MPCPAGOS

ORIGINATOR/KEY CONTACT:

Name: D. N. Mansell and C. C. Barnard Phone: (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road, S.E., Albuquerque, New Mexico 87106

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Calculates (misalignment) sensitivity coefficients for general optical train. Relates output ray motions to individual optical element motions in six degrees of freedom. Used in conjunction with NASTRAN to predict beam jitter effects through a integrated optics/structures approach.

AVAILABLE DOCUMENTATION:

MPCPAGOS Users' Manual, BDM/TAC-78-727-TR. Final Task Report for Sensitivity Analyses of the ALL Optical Train, BDM/TAC-78-793-TR.

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	●	None Simple Saturated Gain Detailed Kinetics	●	None Simple Flow Model Detailed Mixing
TYPE	●	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	● ● ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	●	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	● ●	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET

CODE NAME: MRO

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models the optical performance of linear bands CW, HF, and DF chemical lasers. MRO is similar to BLAZER, except it is a 2-D model. Used as design tool for BDL, NACL, and MIRACL.

AVAILABLE DOCUMENTATION: The BLAZER and MRO Codes, TRW, June 1978 (theory). BLAZER Users Manual (includes use of MRO), TRW, November 1978.

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None		None
	●	Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator	●	Detailed Kinetics	●	Detailed Mixing
TYPE	●	Geometrical	●	CW		Premixed
	●	Physical		Pulsed	●	Scheduled Mixing
			●	HF, DF		Other
				Other		
GEOMETRY	●	Standing Wave		Annular, Radially Flowing		Cylindrical, Radially Flowing
	●	Ring	●	Transversely Flowing	●	Rectangular, Linearly Flowing
	●	Compact		Other		Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D	●	1 D
	●	1 D	●	2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM	●	Cartesian	●	Cartesian	●	Cartesian
		Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments		Single Line		Laminar Flow
	●	Aberrations	●	Multiline		Turbulent Flow
		Deformable Mirrors	●	Line Broadening		Boundary Layer
	●	Far-Field Performance	●	Other		Shocks
		Other			●	Other

CODE SUMMARY SHEET **CODE NAME:** NCFTDPWE*

ORIGINATOR KEY CONTACT: **

Name: F. D. Toppert/John C. Goldstein **Phone:** (505) 667-7281

Organization: Los Alamos Scientific Laboratory

Address: Group X-1, MS-531, Los Alamos, New Mexico 87545

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Study of wavefront distortions during propagation through amplifying self-focusing materials. Code could be extended to resonator calculations, but does not currently have any optical elements or saturable gain models included.

AVAILABLE DOCUMENTATION: A Numerical Code for the Three-Dimensional Parabolic Wave Equation, John C. Goldstein, LASL, LA-6833-MS.

CATEGORY / ATTRIBUTE	OPTICS		KINETICS		GASDYNAMICS	
LEVEL		None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF, DF Other		Premixed Scheduled Mixing Other
GEOMETRY	 ●	Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other		Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	 ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	 ●	Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

*Numerical Code for the Three-Dimensional Parabolic Wave Equation.
**Now at University of Miami, Miami, Florida.

CODE SUMMARY SHEET **CODE NAME:** NORO-I

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman/S. W. Zelazny* Phone: (217) 333-1834

Organization: University of Illinois, Dept. of Aeronautical & Astronautical Eng.

Address: Urbana, Illinois 61801

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Qualitative Rotational nonequilibrium kinetics and fluid dynamics model coupled with Bell Aerospace strip optics code. See ROPTICS.

AVAILABLE DOCUMENTATION: Applied Optics 17, p. 2244 (1978); J. Chem. Phys. 62, p. 3523 (1975); Applied Optics 15, p. 744, (1976); J. Chem. Phys. 67 p. 966 (1977).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None ● Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None ● Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	● CW Pulsed ● HF DF Other	● Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing ● Transversely Flowing Other	Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

*Bell Aerospace Textron

CODE SUMMARY SHEET

CODE NAME: NORO-II

ORIGINATOR/KEY CONTACT:

Name: S. W. Zelazny Phone (716) 297-1000

Organization: Bell Aerospace Textron

Address: P.O. Box 1, Buffalo, New York 14240

PRINCIPAL PURPOSE AND APPLICATION OF CODE: 1-D mixing model coupled to rotational nonequilibrium chemistry and Fabry-Perot models. Used for optical cavity analysis. (See appendix C, table 1).

AVAILABLE DOCUMENTATION:

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator		None Simple Saturated Gain Detailed Kinetics	 ●	None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF DF Other	 ●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular Radially Flowing Transversely Flowing Other		Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other	● ●	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET

CODE NAME: OCELOT

ORIGINATOR/KEY CONTACT:

Name: David Fink Phone: (213) 391-0711, X6925

Organization: Hughes Aircraft Company

Address: Culver City, California 90230

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Tool to assist with resonator design and mode control. Primarily models optics, but modular constructor allows incorporation of other detailed models.

AVAILABLE DOCUMENTATION: Not available

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF/DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	Annular/Radially Flowing Transversely Flowing Other	Cylindrical/Radially Flowing Rectangular/Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations Deformable Mirrors ● Far Field Performance ● Other	Single Line ● Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET 　　　　**CODE NAME:** POLRES

ORIGINATOR/KEY CONTACT:

Name: William P. Latham 　**Phone:** (505) 844-0721

Organization: Air Force Weapons laboratory

Address: AFWL/ALR, Kirtland AFB, New Mexico 87117

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Used for axisymmetric half-symmetric unstable resonator analysis (HSUR); contains two Fourier components for analysis of polarization effects in bare compact beam resonators.

AVAILABLE DOCUMENTATION: None Relevant: G. C. Dente, App. Opt. 18, 2911 (1979), W. P. Latham, "Polarization Effects of Half Symmetric Unstable Resonators with a Coated Rear Cone," App. Opt. (to be published).

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** POLRESH

ORIGINATOR/KEY CONTACT:

Name: William P. Latham **Phone:** (505) 844-0721

Organization: Air Force Weapons Laboratory

Address: AFWL/ALR, Kirtland AFB, New Mexico 87117

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Used for axisymmetric half-symmetric unstable resonator with internal axicon analysis (HSURIA); contains two Fourier components for analysis of polarization effects in bare compact and annular beam resonators. Will eventually include rings and simple saturable gain models.

AVAILABLE DOCUMENTATION: None relevant: G. C. Dente, App. Opt 18, 2911 (1979); W. P. Latham, "Polarization Effects of Half Symmetric Unstable Resonators with a Control Rear Cone," App. Opt (to be published).

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far-Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** POP

ORIGINATOR/KEY CONTACT:

Name: Peter B. Mumola **Phone** (203) 762-4415

Organization: PerlKin-Elmer Corporation

Address: 50 Danbury Road, MS 241, Wilton, Connecticut 06897

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Physical optics analysis of general HEL optical systems and atmospheric propagation. Code can be coupled to variety of detailed kinetics models including CO_2 EDL (pulsed or CW), GDL, and Iodine.

AVAILABLE DOCUMENTATION: Available

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations ● Deformable Mirrors ● Far Field Performance ● Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** PRE-WATSON

ORIGINATOR KEY CONTACT:

Name: Philip D. Briggs Phone: (213) 884-3851

Organization: Rockwell International, Rocketdyne Division

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Evaluate impact on resonator solution of conical element polarization.

AVAILABLE DOCUMENTATION: None. Some papers in open literature.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance ● Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** QFHT

ORIGINATOR/KEY CONTACT:

Name: Paul E. Fileger Phone (305) 840-6643

Organization: United Technologies Research Center

Address: P.O. Box 2691, MS-R-48, West Palm Beach, Florida 33402

PRINCIPAL PURPOSE AND APPLICATION OF CODE: The QFHT code was developed as a tool for modeling high Fresnel number annular resonators (will model collimated Fresnel numbers in excess of 200).

AVAILABLE DOCUMENTATION: None. Listings available.

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None	●	None	●	None
		Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator		Detailed Kinetics		Detailed Mixing
TYPE		Geometrical		CW		Premixed
	●	Physical		Pulsed		Scheduled Mixing
				HF DF		Other
				Other		
GEOMETRY	●	Standing Wave		Annular, Radially Flowing		Cylindrical, Radially Flowing
	●	Ring		Transversely Flowing		Rectangular, Linearly Flowing
	●	Compact		Other		Other
	●	Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
		1 D		2 D		2 D
	●	2 D		3 D		3 D
COORDINATE SYSTEM		Cartesian		Cartesian		Cartesian
	●	Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments		Single Line		Laminar Flow
	●	Aberrations		Multiline		Turbulent Flow
	●	Deformable Mirrors		Line Broadening		Boundary Layer
	●	Far Field Performance		Other		Shocks
	●	Other				Other

CODE SUMMARY SHEET **CODE NAME:** RASCAL

ORIGINATOR/KEY CONTACT:

Name: Phil D. Briggs **Phone:** (213) 884-3851

Organization: Rockwell International - Rockedyne Division

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Resonator parameter selection, assess mode control, performance predictions for power and beam quality, resonator perturbation analysis, beam quality, set/verify design requirements. This is a vector code. Kinetics and mixing models included--see AEROKNS.

AVAILABLE DOCUMENTATION: None

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF DF ● Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	● Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations ● Deformable Mirrors ● Far-Field Performance ● Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME** ROPTICS

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman/S. W. Zelazny (BAT) **Phone** (217) 333-1834

Organization: University of Illinois, Dept. of Aeronautical & Astronautical Eng.

Address: Urbana, Illinois 61801

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Study interaction between rotational nonequilibrium kinetics and optical resonator geometry. Bell Aerospace strip optics code (BATOPT) coupled to qualitative kinetic - fluid dynamics model (NORO-I). Combined model is called ROPTICS.

AVAILABLE DOCUMENTATION: Applied Optics 17, p. 2244 (1978); J. Chem. Phys. 62, 3523 (1975); Applied Optics 15, p. 744 (1976); J. Chem. Phys. 67, 966 (1977).

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None ● Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF DF Other	● Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact Annular	Annular Radially Flowing ● Transversely Flowing Other	Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** ROTKIN

ORIGINATOR/KEY CONTACT:

Name: R. J. Hall Phone: (203) 727-7349

Organization: United Technologies Research Center

Address: Silver Lane, E. Hartford, Connecticut 06108

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Prediction of HF/DF chemical laser performance based on coupled rate equation analysis of chemical, vibrational, rotational, and radiative transfer.

AVAILABLE DOCUMENTATION: Listings available. R. J. Hall, "Rotational Nonequilibrium and Line-Selected Operation in CW DF Chemical Lasers," IEEE JQE, Volume QE-12, p. 453 (1976).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None ● Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None ● Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	● CW Pulsed ● HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	● Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening ● Other	● Laminar Flow ● Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** SAIC2D

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663
Organization: Science Applications, Inc.
Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Provide capability of modeling high order modes in cylindrical/annular optical resonators.

AVAILABLE DOCUMENTATION: None

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None	●	None
		Simple Fabry Perot	●	Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator	●+	Detailed Kinetics		Detailed Mixing
TYPE		Geometrical		CW		Premixed
	●	Physical		Pulsed		Scheduled Mixing
				HF, DF		Other
				Other		
GEOMETRY	●	Standing Wave		Annular, Radially Flowing		Cylindrical, Radially Flowing
	●	Ring		Transversely Flowing		Rectangular, Linearly Flowing
	●	Compact		Other		Other
	●	Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
		1 D		2 D		2 D
	●	2 D		3 D		3 D
COORDINATE SYSTEM	●	Cartesian		Cartesian		Cartesian
	●	Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments		Single Line		Laminar Flow
	●	Aberrations		Multiline		Turbulent Flow
	●	Deformable Mirrors		Line Broadening		Boundary Layer
	●	Far Field Performance		Other		Shocks
		Other				Other

+ with GCAL

CODE SUMMARY SHEET **CODE NAME:** SAIC2DV

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Provide accurate, cost effective method of cylindrical/annular optical resonator mode and power extraction analysis and determine the effect of various design perturbations on these parameters. This code is a vectorized version of SAIC2D.

AVAILABLE DOCUMENTATION: None

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain ●+ Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations ● Deformable Mirrors ● Far-Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

+ with GCAL

CODE SUMMARY SHEET **CODE NAME:** SAIFHT

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Provide accurate, cost effective method of cylindrical/annular optical resonator parametric analysis including power extraction for use in overall system optimization.

AVAILABLE DOCUMENTATION: HF Laser Subsystem Technology Assessment (DARPA Interim Report), Science Applications, Inc., Atlanta, Georgia, July 1979 (CONFIDENTIAL)

CATEGORY / ATTRIBUTE	OPTICS		KINETICS		GASDYNAMICS	
LEVEL	 ●	None Simple Fabry Perot Detailed Resonator	 ● ●+	None Simple Saturated Gain Detailed Kinetics		None Simple Flow Model Detailed Mixing
TYPE	 ●	Geometrical Physical		CW Pulsed HF DF Other		Premixed Scheduled Mixing Other
GEOMETRY	● ● ● ●	Standing Wave Ring Compact Annular		Annular Radially Flowing Transversely Flowing Other		Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	 ● ●	(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D		1 D 2 D 3 D
COORDINATE SYSTEM	● ●	Cartesian Cylindrical Other		Cartesian Cylindrical Other		Cartesian Cylindrical Other
FEATURES MODELED	● ● ●	Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other		Laminar Flow Turbulent Flow Boundary Layer Shocks Other

+ with GCAL

CODE SUMMARY SHEET **CODE NAME** SAIGD

ORIGINATOR KEY CONTACT:

Name: Kerry E. Patterson Phone (404) 955-2663

Organization: Science Applications., Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: (1) Correlate and analyze closed cavity data. (2) Optimize operating conditions and geometric configurations. (3) Generate gain algorithm for wave optics analyses. Lasing and chemical kinetics models are included. Generates gas dynamic/kinetic profiles for gain algorithim (see GCAL).

AVAILABLE DOCUMENTATION: HF Laser Subsystem Technology Assessment (DARPA) Interim Report), Science Applications, Inc., Atlanta, Georgia, July 1979.

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL	●	None		None		None
		Simple Fabry Perot		Simple Saturated Gain		Simple Flow Model
		Detailed Resonator	●	Detailed Kinetics	●	Detailed Mixing
TYPE		Geometrical	●	CW		Premixed
		Physical		Pulsed	●	Scheduled Mixing
			●	HF DF		Other
				Other		
GEOMETRY		Standing Wave	●	Annular Radially Flowing	●	Cylindrical Radially Flowing
		Ring	●	Transversely Flowing	●	Rectangular Linearly Flowing
		Compact		Other	●	Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
		1 D	●	2 D		2 D
		2 D		3 D	●	3 D Psuedo
COORDINATE SYSTEM		Cartesian	●	Cartesian	●	Cartesian
		Cylindrical	●	Cylindrical	●	Cylindrical
		Other		Other		Other
FEATURES MODELED		Misalignments	●	Single Line	●	Laminar Flow
		Aberrations		Multiline	●	Turbulent Flow
		Deformable Mirrors	●	Line Broadening	●	Boundary Layer
		Far Field Performance		Other		Shocks
		Other			●	Other

CODE SUMMARY SHEET **CODE NAME:** SAI1D

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Provide accurate, cost effective method of linear optical resonator mode and power extraction analysis and the effect of various design perturbations on these parameters.

AVAILABLE DOCUMENTATION: None

CATEGORY / ATTRIBUTE		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None	●	None
		Simple Fabry Perot	●	Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator		Detailed Kinetics		Detailed Mixing
TYPE		Geometrical		CW		Premixed
	●	Physical		Pulsed		Scheduled Mixing
				HF DF		Other
				Other		
GEOMETRY	●	Standing Wave		Annular, Radially Flowing		Cylindrical, Radially Flowing
	●	Ring		Transversely Flowing		Rectangular, Linearly Flowing
	●	Compact		Other		Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
	●	1 D		2 D		2 D
		2 D		3 D		3 D
COORDINATE SYSTEM	●	Cartesian		Cartesian		Cartesian
		Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments		Single Line		Laminar Flow
	●	Aberrations		Multiline		Turbulent Flow
		Deformable Mirrors		Line Broadening		Boundary Layer
	●	Far Field Performance		Other		Shocks
		Other				Other

CODE SUMMARY SHEET

CODE NAME: SAI2D

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Atlanta, Georgia 30339

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Modeling of rectangular linear resonators and optical trains.

AVAILABLE DOCUMENTATION: None

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL		None		None	●	None
		Simple Fabry Perot	●	Simple Saturated Gain		Simple Flow Model
	●	Detailed Resonator	●*	Detailed Kinetics		Detailed Mixing
TYPE		Geometrical		CW		Premixed
	●	Physical		Pulsed		Scheduled Mixing
				HF DF		Other
				Other		
GEOMETRY	●	Standing Wave		Annular, Radially Flowing		Cylindrical, Radially Flowing
	●	Ring		Transversely Flowing		Rectangular, Linearly Flowing
	●	Compact		Other		Other
		Annular				
GRID DIMENSION		(Transverse Dimension)		1 D		1 D
		1 D		2 D		2 D
	●	2 D		3 D		3 D
COORDINATE SYSTEM	●	Cartesian		Cartesian		Cartesian
		Cylindrical		Cylindrical		Cylindrical
		Other		Other		Other
FEATURES MODELED	●	Misalignments		Single Line		Laminar Flow
	●	Aberrations		Multiline		Turbulent Flow
	●	Deformable Mirrors		Line Broadening		Boundary Layer
	●	Far Field Performance		Other		Shocks
	●	Other				Other

* with GCAL

CODE SUMMARY SHEET

CODE NAME: SOS

ORIGINATOR/KEY CONTACT:

Name: J. Hough/M. Epstein Phone: (213) 648-6861

Organization: Aerophysics Laboratory, The Aerospace Corporation

Address: P.O. Box 92957, Los Angeles, California 90009

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Calculation of pulsed HF and DF chemical laser performance by solving coupled thermodynamic, chemical kinetic, and radiation transport equations. Utilizes comprehensive chemical kinetics model (including rotational nonequilibrium) and simple Fabry-Perot model.

AVAILABLE DOCUMENTATION: Efficient Model for HF Lasers With Rotational Nonequilibrium, J.J.T. Hough, Aerospace Corp. Repts. SAMSO-TR-78-79, 15 Aug. 1978 and SAMSO-TR-78-84, 14 April 1978.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None ● Simple Fabry Perot Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model Detailed Mixing
TYPE	● Geometrical Physical	CW ● Pulsed ● HF, DF Other	● Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian Cylindrical Other	● Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** TDLCLRC*

ORIGINATOR/KEY CONTACT:

Name: Victor L. Gamiz Phone: (213) 884-3346

Organization: Rockwell International, Rocketdyne Division

Address: 6633 Conoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Performs 3-D wave optics resonator analysis of a positive branch confocal unstable resonator with rectangular spherical mirrors. Has off axis geometry capability. Kinetics and mixing models included - see AEROKNS.

AVAILABLE DOCUMENTATION: High Power Testing of Optical Components (HIPTOC) Technical Proposal Part III, Appendix B (V. L. Gamiz) (theory).

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF DF ● Other	Premixed ● Scheduled Mixing Other
GEOMETRY	Standing Wave ● Ring ● Compact Annular	● Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	● Cartesian Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow ● Boundary Layer Shocks ● Other

*3-D Loaded Cavity Linear Resonator Code.

CODE SUMMARY SHEET

CODE NAME: TDWORRC*

ORIGINATOR/KEY CONTACT:

Name: Victor L. Gamiz Phone: (213) 884-3346

Organization: Rocketdyne, Laser Optics

Address: 6633 Canoga Avenue, Canoga Park, California 91304

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Performs 3-D wave optics resonator analysis of a cylindrical annular ring laser resonator using either a two reflaxicon or a two waxicon beam compactor assembly.

AVAILABLE DOCUMENTATION:

See manuals for LS-14 3-D base and loaded HSURIA codes.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None ● Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF DF Other	Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave ● Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical, Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations ● Deformable Mirrors ● Far Field Performance ● Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

* 3-D Wave Optics Ring Resonator Code.

CODE SUMMARY SHEET **CODE NAME:** TMRO

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Version of MRO code for toric resonators.

AVAILABLE DOCUMENTATION: No theory manual as such, but (TRW) BLAZER and MRO code reports (June 1978) contain much information. See BLAZER User Manual, November 1978.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	None Simple Saturated Gain ● Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical ● Physical	● CW Pulsed ● HF, DF Other	Premixed ● Scheduled Mixing Other
GEOMETRY	● Standing Wave ● Ring Compact ● Annular	● Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D 2 D	● 1 D 2 D 3 D	● 1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other	Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance ● Other	Single Line ● Multiline ● Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks ● Other

CODE SUMMARY SHEET **CODE NAME:** TWODNOZ

ORIGINATOR/KEY CONTACT:

Name: D. Haflinger/P. Lohn Phone: (213) 536-1624

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE:

Calculate nozzle flow including boundary layer and inviscid core analysis.

AVAILABLE DOCUMENTATION: None

CATEGORY / ATTRIBUTE	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF DF Other	● Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing ● Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	● Cartesian Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow Turbulent Flow ● Boundary Layer Shocks Other

CODE SUMMARY SHEET

CODE NAME: URINLA2

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-4384

Organization: TRW DSSG

Address: R1/1162, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Models cylindrical laser with arbitrary axicon (except noneverting waxicon). Bare resonator code which determines mode control and beam quality.

AVAILABLE DOCUMENTATION: Annular Laser Mode Studies Final Report, March 1980. Program URINLA2 User Manual, June 1978.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	None Simple Fabry Perot ● Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	● None Simple Flow Model Detailed Mixing
TYPE	Geometrical ● Physical	CW Pulsed HF, DF Other	Premixed Scheduled Mixing Other
GEOMETRY	● Standing Wave Ring ● Compact ● Annular	Annular, Radially Flowing Transversely Flowing Other	Cylindrical Radially Flowing Rectangular Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) ● 1 D ● 2 D	1 D 2 D 3 D	1 D 2 D 3 D
COORDINATE SYSTEM	Cartesian ● Cylindrical Other	Cartesian Cylindrical Other	Cartesian Cylindrical Other
FEATURES MODELED	● Misalignments ● Aberrations Deformable Mirrors ● Far Field Performance Other	Single Line Multiline Line Broadening Other	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

CODE SUMMARY SHEET **CODE NAME:** VIINT

ORIGINATOR KEY CONTACT:

Name: J. Ohrenberger Phone: (213) 536-4024

Organization: TRW DSSG

Address: 88/1012, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: Viscid/inviscid interaction program; calculates flow between used gas for hypersonic wedge modeling.

AVAILABLE DOCUMENTATION: Ohrenberger, BMDATC, DASG60-76-C-0043, April 1977 (theory). Computer Program Description and Users Manual of a Near and Far Wake Modeling Analysis for Reentry under Turbulent Boundary Layer Conditions, Ohrenberger, for BMDSC, DASG60-76-C-0043, March 1979. Others.

ATTRIBUTE \ CATEGORY	OPTICS	KINETICS	GASDYNAMICS
LEVEL	● None Simple Fabry Perot Detailed Resonator	● None Simple Saturated Gain Detailed Kinetics	None Simple Flow Model ● Detailed Mixing
TYPE	Geometrical Physical	CW Pulsed HF, DF Other	● Premixed Scheduled Mixing Other
GEOMETRY	Standing Wave Ring Compact Annular	Annular, Radially Flowing Transversely Flowing Other	● Cylindrical, Radially Flowing ● Rectangular, Linearly Flowing Other
GRID DIMENSION	(Transverse Dimension) 1 D 2 D	1 D 2 D 3 D	1 D ● 2 D 3 D
COORDINATE SYSTEM	Cartesian Cylindrical Other	Cartesian Cylindrical Other	● Cartesian ● Cylindrical Other
FEATURES MODELED	Misalignments Aberrations Deformable Mirrors Far Field Performance Other	Single Line Multiline Line Broadening Other	● Laminar Flow ● Turbulent Flow ● Boundary Layer ● Shocks Other

CODE SUMMARY SHEET

CODE NAME: WAP*

ORIGINATOR/KEY CONTACT:

Name: J. Ohrenberger Phone (213) 536-4024

Organization: TRW DSSG

Address: 88/1012, One Space Park, Redondo Beach, California 90278

PRINCIPAL PURPOSE AND APPLICATION OF CODE: To determine base flow between laser nozzle. Detailed analysis of base flows, recirculation, and embedded subsonic zone; boundary remnant lip and wake shocks formation are included.

AVAILABLE DOCUMENTATION: Computer Program Description and Users Manual of a Near and Far Wake Modeling Analysis for Reentry under Laminar or Turbulent Boundary Layer Conditions, J. T. Ohrenberger, for BMDATC (DASG60-76-C-0043) April 1977. Others.

ATTRIBUTE \ CATEGORY		OPTICS		KINETICS		GASDYNAMICS
LEVEL	●	None Simple Fabry Perot Detailed Resonator	●	None Simple Saturated Gain Detailed Kinetics	 ●	None Simple Flow Model Detailed Mixing
TYPE		Geometrical Physical		CW Pulsed HF, DF Other	●	Premixed Scheduled Mixing Other
GEOMETRY		Standing Wave Ring Compact Annular		Annular, Radially Flowing Transversely Flowing Other	● ●	Cylindrical, Radially Flowing Rectangular, Linearly Flowing Other
GRID DIMENSION		(Transverse Dimension) 1 D 2 D		1 D 2 D 3 D	 ●	1 D 2 D 3 D
COORDINATE SYSTEM		Cartesian Cylindrical Other		Cartesian Cylindrical Other	●	Cartesian Cylindrical Other
FEATURES MODELED		Misalignments Aberrations Deformable Mirrors Far Field Performance Other		Single Line Multiline Line Broadening Other	● ● ● ● ●	Laminar Flow Turbulent Flow Boundary Layer Shocks Other

*Wake Analysis Program

Section III

DETAILED CHEMICAL LASER CODES

This chapter contains, in alphabetical order, the received detailed responses to the survey form (Appendix A). The material has been reformatted somewhat for economy of presentation and ease of comparison. It was not possible to include the 28 codes submitted by Bell Aerospace in this detailed format; for these, the reader should see Appendix C. See Section IV for an explanation of the forms.

CODE NAME ABL*

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models cylindrical lasers used with URINLA2. This is a URINLA2 model with gain.

ASSESSMENT OF CAPABILITIES: See URINLA2.

ASSESSMENT OF LIMITATIONS: See URINLA2.

OTHER UNIQUE FEATURES: Resonator geometries modeled: HSURIA; "HSURIA" with toric back mirror, TURIA.

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock   Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION. (T = Theory, U = User, RP = Relevant Publication): (T) Annular Laser Mode Studies Final Report; (U) Program ABL User Manual, June 1978; listings available.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): AFWL CYBER 176, NOS/BE.

TRANSPORTABLE?:

Machine Dependent Restrictions:

SELF-CONTAINED?: See MRO/BLAZER

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:		
Large Job:	200K (SCM) + 300K (LCM)	1800

Approximate Number of FORTRAN Lines: 6000

* Annular BLAZER

CODE NAME: ABL

OPTICS

BASIC TYPE (✓)
Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (✓)
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (✓)

	1D	2D
Compact Region		✓*
Annular Region		✓*

FIELD SYMMETRY RESTRICTIONS? Half plane

MIRROR SHAPE(S) ALLOWED (✓)
Square ____ Circular ✓ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (✓)
Fixed: Single Resonator Geometry ____
Fixed: Multiple Resonator Geometries ✓
Modular: Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature	✓	✓
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (✓)
Power Comparison ✓ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? No
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓)
Prony ____
Other ____

RESONATOR TYPE (✓) Standing Wave ✓
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (✓) Positive ✓ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (✓)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ____ Telescopes ✓
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	✓	✓
Linear	✓	✓
Parabola-Parabola		✓
Variable Cone Offset	✓	✓
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements: Rear flat, rear cone HH & HP reflaxicons & waxicons, PP Reflaxicons.

GAIN MODELS (✓) Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (✓)
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) Aberrations only
Reflectivity Loss ✓
Output Coupler Edges: Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (✓)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR FIELD MODELS (✓) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ____

KINETICS

GAIN REGION MODELED (✓)
Compact Region ____ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region CY

KINETICS GRID DIMENSIONALITY (✓)*

	1D	2D	3D
Compact Region			
Annular Region	✓	✓	✓

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ✓ Flow Direction? ✓

PULSED ____ **CW** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (✓)
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$

Y^X	F	Cl	Br	I
H	✓			
D	✓			

Cold $(F + H_2)$ ✓
Hot $(H + F_2)$ ____ Chain $(F + H_2 \& H + F_2)$ ____
Other (specify) ____

ENERGY TRANSFER MODES MODELED (✓) Reference
V-T ✓ See MRO/BLAZER
V-R ____
V-V ✓ See MRO/BLAZER
Other ____

Single Line Model (✓) ____
Multiline Model (✓) ✓

Assumed Rotational Population Distribution State (✓)
Equilibrium ✓ Nonequilibrium ____
Number of Laser Lines Modeled 24
Source of Rate Coefficients Used in Code N. Cohen

LINE PROFILE MODELS (✓)
Doppler Broadening ✓
Collisional Broadening ✓
Other (specify) Operation at line center

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (✓)
Cylindrical: Radially Flowing ✓
Rectangular: Linearly Flowing ____
Other ____

COORDINATE SYSTEM CY

FLUID GRID DIMENSION (✓) 1D ✓ 2D ____ 3D ____

FLOW FIELD MODELED (✓)
Laminar ____ Turbulent ____
Other Scheduled mixing

BASIC MODELING APPROACH (✓)
Premixed ____ Mixing ____
Other (specify) Scheduled mixing

References for Approach Used See MRO/BLAZER

THERMAL DRIVER MODELED (✓)
Arc Heater ____ Combustor ✓
Shock Tube ____ Resistance Heater ____
Other ____

F ATOM DISSOCIATION FROM (✓)
F_2 ✓ SF_6 ____
Other (specify) NF_3

F ATOM CONCENTRATION DETERMINED FROM MODEL? yes

DILUENTS MODELED He, N_2, CF_4

MODELS EFFECTS ON MIXING RATE DUE TO (✓)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) Scheduled mixing

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)
Media Index Variations ____
Other (specify) ____

*See ORIGLAZ User Manual

CODE NAME AERO[illegible]

CODE TYPE Kinetics and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Computation of small signal or loaded gains from a radially [illegible] system for use by annular resonator codes. Package includes aerodynamics for radial flow field.

ASSESSMENT OF CAPABILITIES Allows computation of gain sheet through a radial [illegible] the reaction zone. Allowed transitions are v = 1 - 10, j = 1 - [illegible]; uses latest [illegible] available.

ASSESSMENT OF LIMITATIONS Model does not include rotational nonequilibrium.

OTHER UNIQUE FEATURES

ORIGINATOR/KEY CONTACT

Name Jim Vieceli Phone (213) 884-38[illegible]

Organization Rockwell International - Rocketdyne Division

Address 6633 Canoga Ave., Canoga Park, California 91304

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication) (T) Annular Laser Optics Study Final Report [illegible]-TR-77-117[illegible]; (U) Annular Laser Optics Study Users Manual, Loaded Cavity Codes.

STATUS

Operational Currently? Yes

Under Modification?

Purpose(s)

Ownership? AFWL

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed) [illegible] Cyber 176

TRANSPORTABLE? With modification.

Machine Dependent Restrictions Uses CDC extended core (LCM).

SELF-CONTAINED? No - is a subroutine package.

Other Codes Required (name, purpose) Requires that a driver code provide intensity-transition matrix.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec CDC 7600)
Small Job		
Typical Job		5-10 sec CDC 7600
Large Job		

Approximate Number of FORTRAN Lines

CODE NAME AERONNS

OPTICS

None

BASIC TYPE (√) None

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ____ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry ____

Fixed Multiple Resonator Geometries ____

Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE VECTOR EXTRACTION ALGORITHM (√)

RESONATOR TYPE (√) Standing Wave ____

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ____ Spherical Mirrors ____

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (√)

Compact Region ____ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region CY

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region	✓		

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? ____ Flow Direction? ✓

PULSED ____ CW ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ X + Y_2 \quad YX + Y \right\}$

$\left\{ Y + X_2 \quad YX + X \right\}$

	F	Cl	Br	I
H	✓			
D				

Cold $(F + H_2)$ ✓

Hot $(H + F_2)$ ✓ Chain $(F + H_2$ & $H + F_2)$ ✓

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V T ✓ Cohen

V R ____

V V ✓ Cohen

Other ____

Single Line Model (√) ____

Multiline Model (√) ✓

Assumed Rotational Population Distribution State (√)

Equilibrium ✓ Nonequilibrium ____

Number of Laser Lines Modeled ≤ 12

Source of Rate Coefficients Used in Code Handbook of Chemical Lasers

LINE PROFILE MODELS (√)

Doppler Broadening ✓

Collisional Broadening ✓

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)

Cylindrical Radially Flowing ✓

Rectangular Linearly Flowing ____

Other ____

COORDINATE SYSTEM Cy

FLUID GRID DIMENSION (√) 1D ✓ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar ____ Turbulent ____

Other Scheduled mixing

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ✓

Other (specify) ____

References for Approach Used ALOS Final Report

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other Not modeled

F ATOM DISSOCIATION FROM (√)

F_2 ✓ SF_6 ✓

Other (specify) NF_3

F ATOM CONCENTRATION DETERMINED FROM MODEL? *

DILUENTS MODELED He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ✓ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) Trip

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ✓

Other (specify) ____

* Equilibrium thermochemistry

AD-A093 540   BDM CORP ALBUQUERQUE NM   F/G 20/5

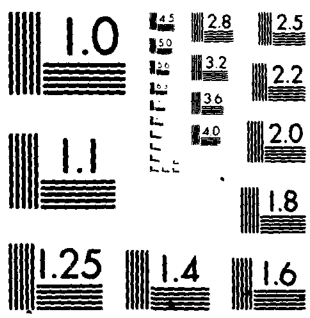
CHEMICAL LASER COMPUTER CODE SURVEY,(U)

DEC 80 C M WIGGINS, D N MANSELL, P B ULRICH   N00173-79-C-0109

UNCLASSIFIED   NRL-8450   NL

[illegible] OF 3

AD



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CODE NAME: AFOPTMNORO

CODE TYPE: Optics and Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Predict power spectral performance of CW chemical laser. Also see MNORO for more detailed kinetics description.

ASSESSMENT OF CAPABILITIES: Predict power spectral distribution for unstable and stable resonators. Strip optics code was provided by Capt. T. Salvi, AFWL/ALR. With rotational Nonequilibrium kinetics, code will predict which lines lase.

ASSESSMENT OF LIMITATIONS: Need to include rotational non-equalibrium on 1-0 band. study.

OTHER UNIQUE FEATURES: Besides power comparison technique to establish convergence, this code compares I(x) on all lines; it also calculates Po/Pc, where Po = total optics power loss and Pc = power available from chemistry.

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman Phone: (217) 333-1834

Organization: Aeronautical and Astronautical Engineering Dept., University of Illinois

Address: Urbana, Illinois 61801

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) "An Efficient Rotational Nonequilibrium Model of a CW Chemical Laser," L. H. Sentman and W. Brandkamp, TR AAE 79-5, UILU Eng 79-0505 (July 1979); (U) "Users Guide for Program MNORO and AFOPTMNORO," L. H. Sentman, AAE TR 79-7, UILU Eng 79-0507 (October 1979).

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: AFOSR

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 175

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:	100K	150 - 800 sec / iteration
Large Job:	272K	(depending on number of points:
Approximate Number of FORTRAN Lines:		about 15 iterations to converge)

CODE NAME: AFOPTMNORO

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: Ca Annular Region: ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region:	✓	
Annular Region:		

FIELD SYMMETRY RESTRICTIONS?: ___
MIRROR SHAPE(S) ALLOWED (√):
Square: ___ Circular: ___ Strip: ✓
Rectangular: ___ Elliptical: ___ Arbitrary: ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ✓
Fixed, Multiple Resonator Geometries: ___
Modular, Multiple Resonator Geometries: ___

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms:		
With Kernel Averaging	✓	
Gaussian Quadrature:		
Fast Fourier Transform (FFT):	✓	
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison: ✓ Field Comparison: ✓
Other: P_{optics}/P_{chem}

ACCELERATION ALGORITHMS USED?: ___
Technique: ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM:(√):
Prony: ___
Other: ___

RESONATOR TYPE (√): Standing Wave: ✓
Traveling Wave (Ring): ___ Reverse TW: ___

BRANCH (√): Positive: ✓ Negative: ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ___ Spherical Mirrors: ___
Cylindrical Mirrors: ✓ Telescopes: ___
Scraper Mirrors: ___

	Waxicons	Reflaxicons
Axicons		
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ___
Spatial Filters: ___ Gratings: ___
Other Elements: ___

GAIN MODELS (√): Bare Cavity Only: ___
Simple Saturated Gain: ___ Detailed Gain: ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ___ Decentration: ___
Aberrations/Thermal Distortions:
Arbitrary: ___
Selected (specify): ___
Reflectivity Loss: ___
Output Coupler Edges: Rolled: ___
Serrated: ___ Other: ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ___
Gas Absorption: ___
Overlapped Beams: ___
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: ___
Optimal Focal Search: ___ Beam Quality: ___
Other: ___

KINETICS

GAIN REGION MODELED (√):
Compact Region: ✓ Annular Region: ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: Ca Annular Region: ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:	✓		
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ___ Flow Direction?: ___

PULSED: ___ CW: ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \rightarrow YX + Y$
$Y + X_2 \rightarrow YX + X$

X \ Y	F	Cl	Br	I
H	✓			
D	✓			

Cold ($F + H_2$): ✓
Hot ($H + F_2$): ✓ Chain ($F + H_2$ & $H + F_2$): ___
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ✓
V-R: ✓
V-V: ___
Other: Multiquantum V-T, F-atom wall recombination.
Single Line Model (√): ___
Multiline Model (√): ✓
Assumed Rotational Population Distribution State (√):
Equilibrium: ___ Nonequilibrium: ✓
Number of Laser Lines Modeled: Predicts which lines lase.
Source of Rate Coefficients Used in Code: Cohen's HF/DF rate package, Hinchen's rotational*

LINE PROFILE MODELS (√):
Doppler Broadening: ___
Collisional Broadening: ___
Other (specify): Voight profile

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√): None
Cylindrical, Radially Flowing: ___
Rectangular, Linearly Flowing: ✓
Other: ___

COORDINATE SYSTEM: Cartesian
FLUID GRID DIMENSION (√): 1D: ✓ 2D: ___ 3D: ___
FLOW FIELD MODELED (√):
Laminar: ___ Turbulent: ___
Other: ___

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: ___
Other (specify): ✓
References for Approach Used: ___

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ___
Shock Tube: ___ Resistance Heater: ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2: ___ SF_6: ___
Other (specify): ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ___
DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ✓ Shock Waves: ___
Pressure (thermal blockage): ___ Turbulence: ___
Other (specify): ✓

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ___
Other (specify): ___

*Relaxation data, Polanyi's pumping distribution

CODE NAME: ALCHRC*

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: LS-14; Resonator parameter selection, assess mode control, performance predictions for power extraction and beam quality, set/verify design requirements.

ASSESSMENT OF CAPABILITIES: Capable of evaluating any general HSURIA with reflaxicon.

ASSESSMENT OF LIMITATIONS: Single gain sheet, axisymmetric model precludes resonator azimuthal perturbation analysis.

OTHER UNIQUE FEATURES: Resonator geometrics modeled; HSURIA with reflaxicon. Axisymmetric mode competition. Twelve fields (combination of transitions and modes).

ORIGINATOR/KEY CONTACT:

Name: Phil Briggs Phone: (213) 884-3581

Organization: Rockwell International-Rocketdyne Division

Address: 6033 Canoga Ave., Canoga Park, California 91304

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) various.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: AFWL

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: With mofification.

Machine Dependent Restrictions: Uses CDC extended core.

SELF-CONTAINED?:

Other Codes Required (name, purpose): Resonator geometry systems code (for other than P-P reflaxicon), axisymmetric far-field code.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:	200K SCM-200K LCM	1000 Octal sec
Typical Job:	200K SCM-250K LCM	2000 Octal sec
Large Job:	200K SCM-600K LCM	10000 Octal sec

Approximate Number of FORTRAN Lines: 3000

* Axisymmetric Loaded Cavity HSURIA Resonator Code

CODE NAME: ALCHRC

OPTICS

BASIC TYPE (√):
Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: CY Annular Region: CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	
Annular Region	✓	

FIELD SYMMETRY RESTRICTIONS?: Axisymmetric

MIRROR SHAPE(S) ALLOWED (√):
Square: ____ Circular: ✓ Strip: ____
Rectangular: ____ Elliptical: ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ✓
Fixed, Multiple Resonator Geometries: ____
Modular, Multiple Resonator Geometries: ____

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):	✓	

Other (specify): Midpoint rule: Compact/ Annular

CONVERGENCE TECHNIQUE (√):
Power Comparison: ____ Field Comparison: ✓
Other: ____

ACCELERATION ALGORITHMS USED?: ____
Technique: ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM:(√):
Prony: ____
Other: ____

RESONATOR TYPE (√): Standing Wave: ✓
Traveling Wave (Ring): ____ Reverse TW: ____

BRANCH (√): Positive: ✓ Negative: ____

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ✓ Spherical Mirrors: ✓
Cylindrical Mirrors: ____ Telescopes: ____
Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		✓
Parabola-Parabola:		✓
Variable Cone Offset:		✓
Other (specify): P-P tanh		✓

Deformable Mirrors: ____
Spatial Filters: ____ Gratings: ____
Other Elements: ____

GAIN MODELS (√): Bare Cavity Only: ____
Simple Saturated Gain: ____ Detailed Gain: ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ____ Decentration: ____
Aberrations/Thermal Distortions:
Arbitrary: Both (radial only)
Selected (specify): ____
Reflectivity Loss: ____
Output Coupler Edges: Rolled: ____
Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ✓ Radial only
Gas Absorption: ✓ Radial only
Overlapped Beams: ____
Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal: ____
Optimal Focal Search: ✓ Beam Quality: ✓
Other: ____

KINETICS

GAIN REGION MODELED (√):
Compact Region: ____ Annular Region: ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: ____ Annular Region: CY

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:	✓		

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ____ Flow Direction?: ✓

PULSED: ____ **CW:** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 = YX + Y$
$Y + X_2 = YX + X$

	~~X~~	F	Cl	Br	I
H		✓			
D		✓			

Cold ($F + H_2$): ✓
Hot ($H + F_2$): ✓ Chain ($F + H_2$ & $H + F_2$): ✓
Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ✓ Cohen
V-R: ____
V-V: ✓ Cohen
Other: ____

Single Line Model (√): ____
Multiline Model (√): ✓

Assumed Rotational Population Distribution State (√):
Equilibrium: ✓ Nonequilibrium: ____

Number of Laser Lines Modeled: ≤ 12

Source of Rate Coefficients Used in Code: Handbook of Chemical Lasers

LINE PROFILE MODELS (√):
Doppler Broadening: ✓
Collisional Broadening: ✓
Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
Cylindrical, Radially Flowing: ✓
Rectangular, Linearly Flowing: ____
Other: ____

COORDINATE SYSTEM: CY

FLUID GRID DIMENSION (√): 1D: ✓ 2D: ____ 3D: ____

FLOW FIELD MODELED (√):
Laminar: ____ Turbulent: ____
Other: Scheduled mixing

BASIC MODELING APPROACH (√):
Premixed: ____ Mixing: ____
Other (specify): ____

References for Approach Used: ALOS Final Report

THERMAL DRIVER MODELED (√):
Arc Heater: ____ Combustor: ____
Shock Tube: ____ Resistance Heater: ____
Other: Not modeled

F-ATOM DISSOCIATION FROM (√):
F_2: ✓ SF_6: ✓
Other (specify): NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: *

DILUENTS MODELED: He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ✓ Shock Waves: ____
Prereactions (thermal blockage): ____ Turbulence: ____
Other (specify): Trip

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ✓
Other (specify): ____

*Equilibrium thermochemistry

CODE NAME: ALCRRC*

CODE TYPE: Optics, Kinetics, and Gasdynamics.

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Resonator parameter selection, assess mode control, performance predictions for power and beam quality, set/verify design requirements.

ASSESSMENT OF CAPABILITIES: Allows evaluation of general ring geometries with independently specified reflaxicons.

ASSESSMENT OF LIMITATIONS: Axisymmetric model precludes resonator azimuthal perturbation analysis.

OTHER UNIQUE FEATURES: Resonator geometries modeled: ring resonator with reflaxicon positive/negitive branch. Axisymmetric mode competition, 5 gain sheets. Twelve fields (combination of transitions and modes).

ORIGINATOR/KEY CONTACT:

Name: Phil D. Briggs Phone: (213) 884-3851

Organization: Rockwell International, Rocketdyne Division

Address: 6633 Canoga Ave., Canoga Park, California 91304

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) various.

STATUS:

Operational Currently?: No

Under Modification?: Being developed.

Purpose(s):

Ownership?: AFWL

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: With modification.

Machine Dependent Restrictions: Uses CDC extended core.

SELF-CONTAINED?:

Other Codes Required (name, purpose): Axisymmetric far-field code.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:	200K SCM-200K LCM	1000 Octal sec
Typical Job:	200K SCM-250K LCM	2000 Octal sec
Large Job:	200K SCM-600K LCM	10000 Octal sec

Approximate Number of FORTRAN Lines: 3000

* Axisymmetric Loaded Cavity Ring Resonator Code

CODE NAME: ALCRRC

OPTICS

BASIC TYPE (√):
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: CY Annular Region: CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	
Annular Region	✓	

FIELD SYMMETRY RESTRICTIONS?: Axisymmetric

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular ✓ Strip: ___
Rectangular ___ Elliptical ___ Arbitrary: ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ✓
Fixed, Multiple Resonator Geometries ___
Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT):		
Fast Hankel Transform (FHT):	✓	✓
Gardner-Fresnel-Kirchhoff (GFK):	✓	

Other (specify): Midpoint rule: Compact/Annular

CONVERGENCE TECHNIQUE (√):
Power Comparison: ___ Field Comparison: ✓
Other: ___

ACCELERATION ALGORITHMS USED?: None
Technique: ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: ___
Other: ___

RESONATOR TYPE (√): Standing Wave: ___
Traveling Wave (Ring): ✓ Reverse TW: ___

BRANCH (√): Positive: ✓ Negative: ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ✓ Spherical Mirrors: ___
Cylindrical Mirrors: ___ Telescopes: ✓
Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		✓
Parabola-Parabola:		✓
Variable Cone Offset:		✓
Other (specify): P-P tanh		✓

Deformable Mirrors: ___
Spatial Filters: ✓ Gratings: ___
Other Elements: ___

GAIN MODELS (√): Bare Cavity Only: ___
Simple Saturated Gain: ___ Detailed Gain: ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ___ Decentration: ___
Aberrations/Thermal Distortions:
Arbitrary: ✓ - Axisymmetric
Selected (specify): ___
Reflectivity Loss: ✓
Output Coupler Edges: Rolled: ___
Serrated: ___ Other: ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ✓ - Axisymmetric
Gas Absorption: ✓ - Axisymmetric
Overlapped Beams: ___
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: ✓
Optimal Focal Search: ✓ Beam Quality: ✓
Other: ___

KINETICS

GAIN REGION MODELED (√):
Compact Region: ___ Annular Region: ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: ___ Annular Region: CY

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:	✓		

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ___ Flow Direction?: ✓

PULSED: ___ CW: ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 = YX + Y$
$Y + X_2 = YX + X$
Cold $(F + H_2)$: ✓

~~X~~	F	Cl	Br	I
H	✓			
D	✓			

Hot $(H + F_2)$: ✓ Chain $(F + H_2$ & $H + F_2)$: ✓
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ✓ Cohen
V-R: ___
V-V: ✓ Cohen
Other: ___

Single Line Model (√): ___
Multiline Model (√): ✓

Assumed Rotational Population Distribution State (√):
Equilibrium: ✓ Nonequilibrium: ___

Number of Laser Lines Modeled: ≤ 12

Source of Rate Coefficients Used in Code: Handbook of Chemical Lasers

LINE PROFILE MODELS (√):
Doppler Broadening: ✓
Collisional Broadening: ✓
Other (specify): ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√):
Cylindrical, Radially Flowing: ✓
Rectangular, Linearly Flowing: ___
Other: ___

COORDINATE SYSTEM: CY

FLUID GRID DIMENSION (√): 1D: ✓ 2D: ___ 3D: ___

FLOW FIELD MODELED (√):
Laminar: ___ Turbulent: ___
Other: Scheduled mixing

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: ✓
Other (specify): ___

References for Approach Used: ALOS Final Report

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ___
Shock Tube: ___ Resistance Heater: ___
Other: Not modeled

F-ATOM DISSOCIATION FROM (√):
F_2: ✓ SF_6: ✓
Other (specify): NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: *

DILUENTS MODELED: He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ✓ Shock Waves: ___
Prereactions (thermal blockage): ___ Turbulence: ___
Other (specify): Trip

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ✓
Other (specify): ___

*Equilibrium thermochemistry

CODE NAME: ALFA

CODE TYPE: Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models any chemically pumped mixing laser system, even electronic transition type. (See also GIM).

ASSESSMENT OF CAPABILITIES: 2-D parabolic reactive, viscous flow code. TKE turbulence (2-equation). (Similar to APACHE, except not time-dependent).

ASSESSMENT OF LIMITATIONS: Cannot model dP/dY in subsonic flows. Contains only Fabry-Perot (geometric) optics packages.

OTHER UNIQUE FEATURES: Besides hot and cold HF and DF kinetics, it also models 3 body recombination H + F + M T HF (v) + M.

ORIGINATOR/KEY CONTACT:

Name: N. L. Rapagnani **Phone:** (505) 844-9836

Organization: Air Force Weapons Laboratory

Address: AFWL/ARAC, Kirtland AFB, New Mexico 87117

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T)(U) AFWL-TR-78-19

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: U.S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY, Cyber-176, CDC-7600, CDC-6600, IBM-370

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: No

Other Codes Required (name, purpose): DYNDIM for dynamic dimensioning. Not necessary on CRAY

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:	65K	15 sec.
Typical Job:	150K	2-5 min.
Large Job:	230K	15-60 min.

Approximate Number of FORTRAN Lines: 2000-2500

CODE NAME: ALFA

OPTICS

None

BASIC TYPE (√)
Physical Optics ___ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ___ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region ___ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS?: ___

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular ___ Strip: ___
Rectangular ___ Elliptical ___ Arbitrary: ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ___
Fixed, Multiple Resonator Geometries: ___
Modular, Multiple Resonator Geometries: ___

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT):		
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison: ___ Field Comparison: ___
Other: ___

ACCELERATION ALGORITHMS USED?: ___
Technique: ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM:(√):
Prony: ___
Other: ___

RESONATOR TYPE (√): Standing Wave: ___
Traveling Wave (Ring): ___ Reverse TW: ___

BRANCH (√): Positive: ___ Negative: ___

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ___ Spherical Mirrors: ___
Cylindrical Mirrors: ___ Telescopes: ___
Scraper Mirrors: ___

	Waxicons	Reflaxicons
Axicons		
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ___
Spatial Filters: ___ Gratings: ___
Other Elements: ___

GAIN MODELS (√): Bare Cavity Only: ___
Simple Saturated Gain: ___ Detailed Gain: ___

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ___ Decentration: ___
Aberrations/Thermal Distortions:
Arbitrary: ___
Selected (specify): ___
Reflectivity Loss: ___
Output Coupler Edges: Rolled: ___
Serrated: ___ Other: ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ___
Gas Absorption: ___
Overlapped Beams: ___
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: ___
Optimal Focal Search: ___ Beam Quality: ___
Other: ___

KINETICS

GAIN REGION MODELED (√):
Compact Region: ✓ Annular Region: ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: ✓ Annular Region: ✓

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:		✓	
Annular Region:		✓	

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ✓ Flow Direction?: ✓

PULSED: ✓ **CW:** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \rightarrow YX + Y$
$Y + X_2 \rightarrow YX + X$
Cold $(F + H_2)$: ✓

Y \ X	F	Cl	Br	I
H	✓			
D	✓			

Hot $(H + F_2)$: ✓ Chain $(F + H_2 \,\&\, H + F_2)$: ✓
Other (specify): 3-body recombination

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ✓ Keber and Hough
V-R: ✓
V-V: ✓
Other: ___

Single Line Model (√): ✓
Multiline Model (√): ✓

Assumed Rotational Population Distribution State (√):
Equilibrium: ✓ Nonequilibrium: ✓

Number of Laser Lines Modeled: Any
Source of Rate Coefficients Used in Code: Cohen

LINE PROFILE MODELS (√):
Doppler Broadening: ✓
Collisional Broadening: ✓
Other (specify): Voight

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
Cylindrical, Radially Flowing: ✓
Rectangular, Linearly Flowing: ✓
Other: ___

COORDINATE SYSTEM: Cartesian & cylindrical

FLUID GRID DIMENSION (√): 1D: ___ 2D: ✓ 3D: ___

FLOW FIELD MODELED (√):
Laminar: ✓ Turbulent: ✓
Other: ✓

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: ___
Other (specify): ✓

References for Approach Used: ___

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ___
Shock Tube: ___ Resistance Heater: ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2: ___ SF_6: ___
Other (specify): ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ___

DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ✓ Shock Waves: ✓
Prereactions (thermal blockage): ___ Turbulence: ___
Other (specify): ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ___
Other (specify): ___

CODE NAME: APACHE

CODE TYPE: Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models any chemically pumped mixing laser system, even electronic transition type. (See also GIM).

ASSESSMENT OF CAPABILITIES: 2-D elliptic, reactive, viscous flow code. TKE turbulence (2-equation). Similar to ALFA, except it is time-dependent.

ASSESSMENT OF LIMITATIONS: Contains only Fabry-Perot (geometric) optics packages.

OTHER UNIQUE FEATURES: Besides hot and cold HF and DF reactions, it also models 3-body recombination $H + F + M \rightarrow HF(v) + M$.

ORIGINATOR/KEY CONTACT:

Name: N. L. Rapagnani   Phone: (505) 844-9836

Organization: Air Force Weapons Laboratory

Address: AFWL/ARAC, Kirtland AFB, New Mexico 87117

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T)(U) LASL-LA 7427

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: U.S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY, Cyber-176, CDC-7600, CDC-6600, IBM-370

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: No

Other Codes Required (name, purpose): DYNDIM for dynamic dimensioning. Not necessary on CRAY.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:	65K/250K ECS	1-2 hours
Large Job:	77K/400K ECS	2+ hours

Approximate Number of FORTRAN Lines: 2000-2500

CODE NAME: APACHE

OPTICS

None

BASIC TYPE (√):
Physical Optics ____ Geometrical √

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____
MIRROR SHAPE(S) ALLOWED (√):
Square: ____ Circular: ____ Strip: ____
Rectangular: ____ Elliptical: ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ____
Fixed, Multiple Resonator Geometries: ____
Modular, Multiple Resonator Geometries: ____

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)		

Other (specify): ____

CONVERGENCE TECHNIQUE (√):
Power Comparison: ____ Field Comparison: ____
Other: ____

ACCELERATION ALGORITHMS USED?: ____
Technique: ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: ____
Other: ____

RESONATOR TYPE (√): Standing Wave: ____
Traveling Wave (Ring): ____ Reverse TW: ____

BRANCH (√): Positive: ____ Negative: ____

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ____ Spherical Mirrors: ____
Cylindrical Mirrors: ____ Telescopes: ____
Scraper Mirrors: ____

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ____
Spatial Filters: ____ Gratings: ____
Other Elements: ____

GAIN MODELS (√): Bare Cavity Only: ____
Simple Saturated Gain: ____ Detailed Gain: ____

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ____ Decentration: ____
Aberrations/Thermal Distortions:
Arbitrary: ____
Selected (specify): ____
Reflectivity Loss: ____
Output Coupler Edges: Rolled: ____
Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal ____
Optimal Focal Search: ____ Beam Quality: ____
Other: ____

KINETICS

GAIN REGION MODELED (√):
Compact Region: √ Annular Region: √

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: √ Annular Region: √

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:		√	
Annular Region:		√	

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? √ Flow Direction? √

PULSED: √ **CW:** √ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{ \begin{array}{l} X + Y_2 = YX + Y \\ Y + X_2 = YX + X \end{array} \right\}$

$\cancel{Y}X$	F	Cl	Br	I
H	√			
D	√			

Cold ($F + H_2$): √
Hot ($H + F_2$): √ Chain ($F + H_2$ & $H + F_2$): √
Other (specify): 3-body recombination

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: √ Kerber and Hough
V-R: √
V-V: √
Other ____

Single Line Model (√) √
Multiline Model (√) √
Assumed Rotational Population Distribution State (√):
Equilibrium: √ Nonequilibrium: √
Number of Laser Lines Modeled: Any
Source of Rate Coefficients Used in Code: Cohen

LINE PROFILE MODELS (√):
Doppler Broadening √
Collisional Broadening √
Other (specify): Voight

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
Cylindrical, Radially Flowing √
Rectangular, Linearly Flowing √
Other ____

COORDINATE SYSTEM: Cartesian & cylindrical
FLUID GRID DIMENSION (√): 1D ____ 2D √ 3D √
FLOW FIELD MODELED (√):
Laminar √ Turbulent √
Other: Recirculating

BASIC MODELING APPROACH (√):
Premixed: ____ Mixing: ____
Other (specify): ____
References for Approach Used ____

THERMAL DRIVER MODELED (√):
Arc Heater: ____ Combustor: ____
Shock Tube: ____ Resistance Heater ____
Other: ____

F-ATOM DISSOCIATION FROM (√):
F_2: ____ SF_6 ____
Other (specify): ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____
DILUENTS MODELED: ____
MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: √ Shock Waves √
Prereactions (thermal blockage) ____ Turbulence √
Other (specify): ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ____
Other (specify): ____

CODE NAME: BAREPL

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: 3-D Bare Cavity Resonator Code. The code was designed to model a Half-Symmetric Unstable Resonator with an Internal Axicon (HSURIA). Performance prediction for beam quality and mode loss difference, set/verify design requirements.

ASSESSMENT OF CAPABILITIES: General field modifiers. Mirror misalignment, misfigure, struts, deformable mirrors.

ASSESSMENT OF LIMITATIONS: Half-plane symmetry restricted to HSURIA, axisymmetric or 3-D calculation.

OTHER UNIQUE FEATURES: Resonator geometries modeled: HSURIA, unstable P-P waxicon (by updating). General field modifier with deformable mirrors to correct for any aberrations.

ORIGINATOR/KEY CONTACT:

Name: Alexander M. Simonoff Phone: (213) 884-3346

Organization: Rocketdyne, Laser Optics

Address: 6633 Canoga Ave., Canoga Park, California

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T)(U) 3-D bare cavity resonator code.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: AFWL

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: Yes (with modification)

Machine Dependent Restrictions: Uses CDC extended core.

SELF-CONTAINED?: No, resonator geometry systems code (for other than P-P reflaxicon) 3-D far-field code.

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)	
Small Job:	<250K	300-600	Octal sec.
Typical Job:	<250K	1500	Rev. N6
Large Job:	<250K	5000	CDC 176

Approximate Number of FORTRAN Lines:

CODE NAME: BAREPL

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS?: ____

MIRROR SHAPE(S) ALLOWED (√):
Square ____ Circular ✓ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ____
Fixed, Multiple Resonator Geometries ____
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)	✓	

Other (specify) ____

CONVERGENCE TECHNIQUE (√):
Power Comparison ____ Field Comparison ____
Other Prony method

ACCELERATION ALGORITHMS USED?: ____
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ✓
Other: ____

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring): ____ Reverse TW ____

BRANCH (√): Positive ✓ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ✓ Spherical Mirrors ✓
Cylindrical Mirrors ____ Telescopes: ____
Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:	✓*	✓
Linear:		
Parabola-Parabola:	✓	✓
Variable Cone Offset:		✓
Other (specify):		✓

Deformable Mirrors: ✓
Spatial Filters: ____ Gratings: ____
Other Elements: Corner cube by using general field modifier to model.

GAIN MODELS (√): Bare Cavity Only: ____
Simple Saturated Gain ✓ Detailed Gain: ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ✓ Decentration ✓
Aberrations/Thermal Distortions:
Arbitrary: ____
Selected (specify): ____
Reflectivity Loss ✓
Output Coupler Edges: Rolled: ____
Serrated: ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other: ____

KINETICS

GAIN REGION MODELED (√): None
Compact Region: ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ____ Flow Direction?: ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$

	F	Cl	Br	I
X				
H				
D				

Cold $(F + H_2)$: ____
Hot $(H + F_2)$: ____ Chain $(F + H_2 \& H + F_2)$ ____
Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T ____
V-R ____
V-V ____
Other ____

Single Line Model (√): ____
Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium ____
Number of Laser Lines Modeled: ____
Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√):
Doppler Broadening ____
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM: ____

FLUID GRID DIMENSION (√): 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√):
Laminar: ____ Turbulent: ____
Other ____

BASIC MODELING APPROACH (√):
Premixed ____ Mixing ____
Other (specify): ____
References for Approach Used ____

THERMAL DRIVER MODELED (√):
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (√):
F_2 ____ SF_6 ____
Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED: ____

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations ____
Other (specify) ____

*With update

CODE NAME: BCCLC*

CODE TYPE: Optics and Kinetics.

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Modeling lasers with conventional unstable resonators with round, elliptical, or rectangular apertures.

ASSESSMENT OF CAPABILITIES:

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES: CO_2 GDL kinetics and shock wave phase sheets. Models conventional unstable resonators. Contains amplifier pass.

ORIGINATOR/KEY CONTACT:

Name: Capt. Ted Salvi or Al Paxton Phone: (505) 844-0721

Organization: Air Force Weapons Laboratory

Address: AFWL/ALR Kirtland AFB, New Mexico 87117

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) (U) None; listing is commented.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Government (AFWL)

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?:

Machine Dependent Restrictions: Plot routines; some I/O; ECS.

SELF-CONTAINED?:

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: 2500

* Baumgardner Cylindrical Coordinate Laser Code

CODE NAME: BCCLC*

OPTICS

BASIC TYPE (√):
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region Ca Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		✓
Annular Region		

FIELD SYMMETRY RESTRICTIONS?: ___

MIRROR SHAPE(S) ALLOWED (√):
Square ✓ Circular ✓ Strip ___
Rectangular ✓ Elliptical ✓ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ___
Fixed, Multiple Resonator Geometries: ___
Modular, Multiple Resonator Geometries: ✓*

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms:		
With Kernel Averaging	✓	
Gaussian Quadrature:		
Fast Fourier Transform (FFT):	✓	
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison: ___ Field Comparison: ___
Other: None

ACCELERATION ALGORITHMS USED?: No
Technique: ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: ___
Other: ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring): ___ Reverse TW: ___

BRANCH (√): Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ✓ Spherical Mirrors ✓
Cylindrical Mirrors: ✓ Telescopes ✓
Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ___
Spatial Filters: ___ Gratings: ___
Other Elements: ___

GAIN MODELS (√): Bare Cavity Only: ✓
Simple Saturated Gain: ___ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ✓ Decentration: ___
Aberrations/Thermal Distortions:
Arbitrary: ✓
Selected (specify): ___
Reflectivity Loss: ___
Output Coupler Edges: Rolled: ___
Serrated: ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ✓
Gas Absorption: ___
Overlapped Beams: ✓ (two beams)
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: ✓
Optimal Focal Search: ✓ Beam Quality: ✓
Other ___

KINETICS

GAIN REGION MODELED (√):
Compact Region: ✓ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: Ca Annular Region: ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			✓
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: Yes Flow Direction?: Yes

PULSED: ___ **CW:** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \rightarrow YX + Y$
$Y + X_2 \rightarrow YX + X$

$\cancel{X}$	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$: ___
Hot $(H + F_2)$: ___ Chain $(F + H_2$ & $H + F_2)$: ___
Other (specify): CO_2

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ___
V-R: ___
V-V: ___
Other: ___
Single Line Model (√): ✓
Multiline Model (√): ___
Assumed Rotational Population Distribution State (√):
Equilibrium: ___ Nonequilibrium: ___
Number of Laser Lines Modeled: 1
Source of Rate Coefficients Used in Code: ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ✓
Other (specify): ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):** None
Cylindrical, Radially Flowing: ___
Rectangular, Linearly Flowing: ___
Other ___

COORDINATE SYSTEM: ___

FLUID GRID DIMENSION (√): 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√):
Laminar: ___ Turbulent: ___
Other: ___

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: ___
Other (specify): ___
References for Approach Used: ___

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ___
Shock Tube: ___ Resistance Heater: ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2 ___ SF_6 ___
Other (specify): ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ___

DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers ___ Shock Waves ___
Preractions (thermal blockage) ___ Turbulence ___
Other (specify): ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations ___
Other (specify): ___

*Limited

CODE NAME: BLAZER

CODE TYPE: Optics, Kinetics, and Gasdynamics.

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models the optical performance of linear bank CW HF and DF chemical lasers. MRO is 2D model; BLAZER is 3D model. Used as design tools for BDL, NACL, MIRACL.

ASSESSMENT OF CAPABILITIES: Resonator: Positive or negative branch confocal unstable; arbitrary optical axis position; cylindrical, toric, or spherical mirrors. Gain medium: CW flowing HF* or DF*, strut wake, mirror aberration, thermal distortion, and nonresonant index OPD's

MRO does stable Fabry Perot with geometrical optics.

ASSESSMENT OF LIMITATIONS: Lacks transverse pressure gradient modeling capability, lacks FFT propagation algorithm, uses only single gain sheet, uses only rotational equilibrium description.

OTHER UNIQUE FEATURES: Confocal unstable resonator modeled.

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: R1/1162, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): The BLAZER and MRO Codes, June 1978; (U): BLAZER User Manual, November 1978 (includes MRO); Listings available.

STATUS:

Operational Currently?: Yes

Under Modification?: Planned

Purpose(s): Rotational nonequilibrium, FFT propagation algorithm, multiple gain skins, transverse pressure gradient description.

Ownership?: Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): Cyber 174-TRW/TSS

TRANSPORTABLE?: Needs mods for export

Machine Dependent Restrictions: CDC

SELF-CONTAINED?:

Other Codes Required (name, purpose): VIINT, KBLIMP, ALFA for nozzle exit condition.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)		Execution Time (Sec, CDC 7600)	
Small Job:	MRO: ----	BLAZER: -	---	---
Typical Job:	151K	165K	400	6500
Large Job:	---	245K	---	15000

Approximate Number of FORTRAN Lines: MRO: 4500 BLAZER: 6000

CODE NAME: BLAZER

OPTICS

BASIC TYPE (√):
Physical Optics: ✓ Geometrical: ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar: ✓ Vector: ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: Ca Annular Region: ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D *	2D +
Compact Region		✓
Annular Region		

FIELD SYMMETRY RESTRICTIONS?: None

MIRROR SHAPE(S) ALLOWED (√):
Square: ✓ Circular: ___ Strip: ___
Rectangular: ✓ Elliptical: ___ Arbitrary: ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ___
Fixed, Multiple Resonator Geometries: ___
Modular, Multiple Resonator Geometries: ___

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature (Modified)	✓	
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)		

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison: ✓ Field Comparison: ___
Other: ___

ACCELERATION ALGORITHMS USED?: No
Technique: ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: ___
Other: ___

RESONATOR TYPE (√): Standing Wave: ✓
Traveling Wave (Ring): ✓ Reverse TW: ___

BRANCH (√): Positive: ✓ Negative: ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ___ Spherical Mirrors: ✓
Cylindrical Mirrors: ✓ Telescopes: ___
Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ___
Spatial Filters: ___ Gratings: ___
Other Elements: ___

GAIN MODELS (√): Bare Cavity Only: ___
Simple Saturated Gain: ___ Detailed Gain: ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ✓ Decentration: ___
Aberrations/Thermal Distortions:
Arbitrary: ✓
Selected (specify): ___
Reflectivity Loss: ✓
Output Coupler Edges: Rolled: ___
Serrated: ___ Other: ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ✓
Gas Absorption: ___
Overlapped Beams: ___
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: ___
Optimal Focal Search: ___ Beam Quality: ✓
Other: EMBLAZON

KINETICS

GAIN REGION MODELED (√):
Compact Region: ✓ Annular Region: ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: Ca Annular Region: ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:		✓	
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ✓ Flow Direction?: ✓

PULSED: ___ **CW:** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$\left\{ \begin{array}{l} X + Y_2 = YX + Y \\ Y + X_2 = YX + X \end{array} \right\}$

X	F	Cl	Br	I
H	✓			
D	✓			

Cold ($F + H_2$): ✓
Hot ($H + F_2$): ___ Chain ($F + H_2$ & $H + F_2$): ___
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ✓ The BLAZER and MRO Codes
V-R: ___
V-V: ✓ The BLAZER and MRO Codes
Other: RR with rot, nonequil.
Single Line Model (√): ___
Multiline Model (√): ✓
Assumed Rotational Population Distribution State (√):
Equilibrium: ✓ Nonequilibrium: ___
Number of Laser Lines Modeled: 24
Source of Rate Coefficients Used in Code: N. Cohen

LINE PROFILE MODELS (√):
Doppler Broadening: ✓
Collisional Broadening: ✓
Other (specify): Operation at line center.

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
Cylindrical, Radially Flowing: ___
Rectangular, Linearly Flowing: ✓
Other: ___

COORDINATE SYSTEM: Cartesian

FLUID GRID DIMENSION (√): 1D: ✓ 2D: ___ 3D: ___

FLOW FIELD MODELED (√):
Laminar: ___ Turbulent: ___
Other: Scheduled mixing.

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: ___
Other (specify): Scheduled mixing.

References for Approach Used: The BLAZER and MRO Codes (TRW).

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ✓
Shock Tube: ___ Resistance Heater: ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2: ✓ SF_6: ___
Other (specify): NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: Yes

DILUENTS MODELED: He, N_2, CF_4

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ___ Shock Waves: ___
Prereactions (thermal blockage): ___ Turbulence: ___
Other (specify): Scheduled three stream: fuel, oxidant, mixed.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ✓
Other (specify): ___

CODE NAME: BLIST

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculates nonsimilar development of 2-D or axisymmetric compressible laminar boundary layers with wall heat transfer.
(BLIST: Boundary Layer Integral Solution Technique)

ASSESSMENT OF CAPABILITIES: Yields reliable solutions of boundary layer properties including skin friction, heat transfer rate, and velocity profiles up to separation.

ASSESSMENT OF LIMITATIONS: Will analyze only nonreacting flow.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:
Name: R. Hughes/D. Haflinger/H. Behrens
Phone: (213) 536-2757
Organization: TRW DSSG
Address: R1/1038, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) Internal Report: "A Description of the Laminar Integral Boundary Layer Model," TRW Report, August 1977; (U) same; listing proprietary.

STATUS:
Operational Currently?: Yes
Under Modification?: No
Purpose(s):

Ownership?: TRW
Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 174

TRANSPORTABLE?: No
Machine Dependent Restrictions: TRW numerical subroutines are used in BLIST.

SELF-CONTAINED?: No
Other Codes Required (name, purpose): TRW subroutines.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	53K	10
Typical Job:	53K	50
Large Job:	53K	100

Approximate Number of FORTRAN Lines: 1000

CODE NAME: BLIST

OPTICS

BASIC TYPE (√) None

Physical Optics ___ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ___ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ___ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ___

MIRROR SHAPE(S) ALLOWED (√)

Square ___ Circular ___ Strip ___

Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry ___

Fixed Multiple Resonator Geometries ___

Modular Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√)

Power Comparison ___ Field Comparison ___

Other ___

ACCELERATION ALGORITHMS USED? ___

Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ___

Other ___

None

RESONATOR TYPE (√) Standing Wave ___

Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√) Positive ___ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ___ Spherical Mirrors ___

Cylindrical Mirrors ___ Telescopes ___

Scraper Mirrors ___

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ___

Spatial Filters ___ Gratings ___

Other Elements ___

GAIN MODELS (√) Bare Cavity Only ___

Simple Saturated Gain ___ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt ___ Decentration ___

Aberrations/Thermal Distortions

Arbitrary ___

Selected (specify) ___

Reflectivity Loss ___

Output Coupler Edges Rolled ___

Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ___

Gas Absorption ___

Overlapped Beams ___

Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ___

Optimal Focal Search ___ Beam Quality ___

Other ___

KINETICS

GAIN REGION MODELED (√) None

Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axis? ___ Flow Direction? ___

PULSED ___ CW ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___

Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___

Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference

V-T ___

V-R ___

V-V ___

Other ___

Single Line Model (√) ___

Multiline Model (√) ___

Assumed Rotational Population Distribution State (√)

Equilibrium ___ Nonequilibrium ___

Number of Laser Lines Modeled ___

Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)

Doppler Broadening ___

Collisional Broadening ___

Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)

Cylindrical Radially Flowing ✓

Rectangular Linearly Flowing ✓

Other ___

COORDINATE SYSTEM Streamline

FLUID GRID DIMENSION (√) 1D ___ 2D ✓ 3D ___

FLOW FIELD MODELED (√)

Laminar ✓ Turbulent ___

Other ___

BASIC MODELING APPROACH (√)

Premixed ___ Mixing ___

Other (specify) ___

References for Approach Used Klineberg-Lees procedure

THERMAL DRIVER MODELED (√)

Arc Heater ___ Combustor ___

Shock Tube ___ Resistance Heater ___

Other ___

F-ATOM DISSOCIATION FROM (√)

F_2 ___ SF_6 ___

Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ___ Shock Waves ___

Prereactions (thermal blockage) ___ Turbulence ___

Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ___

Other (specify) ___

CODE NAME: CLOQ

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The CLOQ code was developed to analyze linear chemical lasers systems using rotational nonequilibrium kinetics.

ASSESSMENT OF CAPABILITIES: The code will model linear resonators with collimated Fresnel numbers of ≤ 100. (Can model optics phenomena describable in terms of one transverse dimension. This independent variable can be expressed either as a Cartesian coordinate or as a cylindrical coordinate -- apparently.)

ASSESSMENT OF LIMITATIONS: Normal limitations of a 2-D analysis. For detailed analysis of specific nozzle types, requires scheduled flow parameters from a code (such as ALFA) having sophisticated gas dynamic calculations.

OTHER UNIQUE FEATURES: Models beam/mode rotation. Code employs a schedule mixing model with different mixing lengths for primary and secondary mixing zones. Allows use of linear, exponential, or tabular mixing rates.

ORIGINATOR/KEY CONTACT:

Name: Paul E. Fileger Phone: (305)840-6643

Organization: United Technologies Research Center, OATL

Address: P. O. Box 2691, MS-R48, West Palm Beach, Florida 33402

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (RP) R. J. Hall, "Rotational Nonequilibrium and Line-Selected Operation in CW DF Chemical Lasers," IEEE JQE, QE-12, 453 (1976).

STATUS:

Operational Currently? Yes

Under Modification? No

Purpose(s):

Ownership? UTRC

Proprietary? Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC 176, IBM 370

TRANSPORTABLE? Yes

Machine Dependent Restrictions: None

SELF-CONTAINED? Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		60
Typical Job	All same: 174K	1200
Large Job		1800

Approximate Number of FORTRAN Lines:

CODE NAME: CLOO

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian cylindrical etc.)
Compact Region Both Annular Region Both*

TRANSVERSE GRID DIMENSIONALITY (√)

		1D	2D
Compact Region	Cart. or cy*	✓	
Annular Region	Cart. or cy*	✓	

FIELD SYMMETRY RESTRICTIONS? Yes

MIRROR SHAPE(S) ALLOWED (√)
Square ___ Circular ___ Strip ✓
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ___
Fixed Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√)
Power Comparison ✓ Field Comparison ✓
Other ___

ACCELERATION ALGORITHMS USED? Yes
Technique Scheduled gain & field averaging.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ✓
Other ___

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ___

BRANCH (√) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ✓ Telescopes ___
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear	✓	
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ✓
Spatial Filters ✓ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ___
Simple Saturated Gain ___ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ✓ (one dimensional)
Selected (specify) ___
Reflectivity Loss ✓
Output Coupler Edges Rolled ✓
Serrated ✓ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ✓
Gas Absorption ✓
Overlapped Beams ✓ (arbitrary number)
Other ___

FAR FIELD MODELS (√) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ___

KINETICS

GAIN REGION MODELED (√)
Compact Region ✓ Annular Region ✓

COORDINATE SYSTEM (Cartesian cylindrical etc.)
Compact Region Both Annular Region Both

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region	✓		
Annular Region	✓		

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axis? ✓ Flow Direction? ✓

PULSED ___ **CW** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√)
X + Y_2 YX + Y
Y + X_2 YX + X ✓
Cold (F + H_2) ✓
Hot (H + F_2) ___ Chain (F + H_2 & H + F_2) ___
Other (specify) ___

X\Y	F	Cl	Br	I
H	✓			
D	✓			

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ✓
V-R ✓
V-V ✓
Other ___

Single Line Model (√) ✓
Multiline Model (√) ✓
Assumed Rotational Population Distribution State (√)
Equilibrium ✓ Nonequilibrium ✓
Number of Laser Lines Modeled Up to 20 of 68
Source of Rate Coefficients Used in Code
ALFA kinetics.

LINE PROFILE MODELS (√)
Doppler Broadening ✓
Collisional Broadening ✓
Other (specify) Voight

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)**
Cylindrical Radially Flowing ✓
Rectangular Linearly Flowing ✓
Other ___

COORDINATE SYSTEM Cartesian or cylindrical

FLUID GRID DIMENSION (√) 1D ✓ 2D ___ 3D ___

FLOW FIELD MODELED (√)
Laminar ✓ Turbulent ✓
Other Scheduled mising/different length

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ✓
Other (specify) Flow properties specified by anchoring to device data using ALFA.
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) Specified by ALFA code.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ✓
Other (specify) ___

*This is a strip code

CODE NAME: CL0Q3D

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: CL0Q3D is an input scheduled code for analyzing HEL chemical lasers using wave optics coupled to rotational nonequilibrium kinetics or to equilibrium kinetics -- HF or DF. Gasdynamics capabilities include: 1-D, scheduled area, scheduled pressure, all aerodynamics scheduled, and radial flow.

ASSESSMENT OF CAPABILITIES: The code is capable of analyzing a large number of annular or linear, unstable or ring resonator systems having overall collimated Fresnel numbers generally ≤30 (single step collimated Fresnel number < 250). Models HSURIA, positive and negative compact unstable confocal resonators, rings, and rings with injection locking, inter-focal line aperture, and inter-focal point aperture.

ASSESSMENT OF LIMITATIONS: Limited to resonators with Fresnel numbers less than 250. Gasdynamics are "generally" provided by ALFA analysis although 1-D, 3 stream scheduled mixing G/D are included in this code.

OTHER UNIQUE FEATURES: Models beam/mode rotation, intra and extra cavity phase correction, and mirror strut supports. Scheduled mixing model used different mixing lengths for primary and secondary mixing zones. Linear, exponential, or tabular mixing rates are available to the flow field model.

ORIGINATOR/KEY CONTACT

Name: Paul E. Fileger Phone: (305) 840-6643

Organization: United Technologies Research Center, OATL

Address: P. O. Box 2691, MS-R-48, West Palm Beach, Florida 33402

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication): User's manual publication date is February 1980. (RP) SOQ user's manual.

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): Incorporate vector (polarization) field, incorporate more sophisticated (geometric mapping) axicon model.

Ownership?: USAF/UTRC

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC-176; kinetics also available on IBM-370.

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: The FFT routine (CPFT) is CDC system dependent.

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose): None for optics; ALFA code is used for gasdynamics inputs.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		15 sec/iteration
Typical Job	Same for all 2146K	410 sec/iteration
Large Job		740 sec/iteration

Approximate Number of FORTRAN Lines: 4300

CODE NAME: CLOQ3D

OPTICS

BASIC TYPE (√):
Physical Optics: √ Geometrical: ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar: √ Vector: (in progress)

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: Ca Annular Region: cy

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region: Ca *		√
Annular Region: cy		√

FIELD SYMMETRY RESTRICTIONS?: None

MIRROR SHAPE(S) ALLOWED (√):
Square: √ Circular: √ Strip: √
Rectangular: √ Elliptical: √ Arbitrary: √

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ___
Fixed, Multiple Resonator Geometries: ___
Modular, Multiple Resonator Geometries: √

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT):	√	√
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK):		

Other (specify): Radial asymptotic propagator (annular)

CONVERGENCE TECHNIQUE (√):
Power Comparison: √ Field Comparison: √
Other: ___

ACCELERATION ALGORITHMS USED?: √
Technique: Scheduled gain & field averaging.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: √
Other: ___

RESONATOR TYPE (√): Standing Wave: √
Traveling Wave (Ring): √ Reverse TW: √

BRANCH (√): Positive: √ Negative: √

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: √ Spherical Mirrors: √
Cylindrical Mirrors: √ Telescopes: √ (geometric)
Scraper Mirrors: √

Axicons	Waxicons	Reflaxicons
Arbitrary:	in progress	
Linear:	√	
Parabola-Parabola:		
Variable Cone Offset:	√	
Other (specify):		

Deformable Mirrors: √
Spatial Filters: √ Gratings: ___
Other Elements: Misaligned and offset cones.

GAIN MODELS (√): Bare Cavity Only: ___
Simple Saturated Gain: ___ Detailed Gain: √

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: √ Decentration: √
Aberrations/Thermal Distortions:
Arbitrary: √
Selected (specify): ___
Reflectivity Loss: √
Output Coupler Edges: Rolled: √
Serrated: √ Other: ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: √
Gas Absorption: √
Overlapped Beams: √ (arbitrary no.)
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: √
Optimal Focal Search: √ Beam Quality: √
Other: Quadratric phase removal.

KINETICS

GAIN REGION MODELED (√):
Compact Region: √ Annular Region: √

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: Both Annular Region: Both

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:	√		
Annular Region:		√	

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: √ Flow Direction?: √

PULSED: ___ **CW:** √ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \rightarrow YX + Y$
$Y + X_2 \rightarrow YX + X$

$\cancel{X}$	F	Cl	Br	I
H	√			
D	√			

Cold $(F + H_2)$: √
Hot $(H + F_2)$: ___ Chain $(F + H_2$ & $H + F_2)$: ___
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: √
V-R: √
V-V: √
Other: ___
Single Line Model (√): √
Multiline Model (√): √
Assumed Rotational Population Distribution State (√):
Equilibrium: √ Nonequilibrium: √
Number of Laser Lines Modeled: Up to 68 (select any 20)
Source of Rate Coefficients Used in Code: ALFA code for DF; Polyani-Woodall to HF; others

LINE PROFILE MODELS (√):
Doppler Broadening: √
Collisional Broadening: √
Other (specify): Voight

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√):
Cylindrical, Radially Flowing: √
Rectangular, Linearly Flowing: √
Other: ___

COORDINATE SYSTEM: Ca or cy

FLUID GRID DIMENSION (√): 1D: √ 2D: ___ 3D: ___

FLOW FIELD MODELED (√):
Laminar: √ Turbulent: √
Other: Scheduled mixing with different mixing lengths

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: √
Other (specify): Flow properties specified by anchoring to device data using ALFA code.
References for Approach Used: ___

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ___
Shock Tube: ___ Resistance Heater: ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2: ___ SF_6: ___
Other (specify): ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ___

DILUENTS MODELED: He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ___ Shock Waves: ___
Prereactions (thermal blockage): ___ Turbulence: ___
Other (specify): Specified by ALFA code.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: √
Other (specify): ___

*cylindrical in progress

CODE NAME: CLSLGM*

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Assess optical performance of MIRACL device before, during, and after acceptance testing without "breaking the bank."

ASSESSMENT OF CAPABILITIES: Very flexible because of modular programming approach; faster run time due to empirical gain modeling approach. Gain is modeled via empirical "fit" to BLAZER predictions.

ASSESSMENT OF LIMITATIONS: Not suitable for cylindrical problems; gain medium device specific (i.e., not a design code). Detailed kinetic/gas dynamics are not calculated from first principals, but instead are empirically modeled.

OTHER UNIQUE FEATURES: Currently configured for MIRACL resonator (spherical on-axis unstable resonator) but easily adaptable to other geometries due to modular code philosophy.

ORIGINATOR/KEY CONTACT:

Name: Peter R. Carlson/Robert E. Hodder Phone: (305) 283-3380

Organization: Science Applications, Inc.

Address: 201 S.W. Monterey Rd., Suite 30, Stuart, Florida 33494

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) (Essentially same formalism as developed by Sziklas and Siegman at Pratt and Whitney for their SOQ codes); (RP) P. Carlson and R. Hodder, "Chemical-Laser Scaling-Law Gain Model Analysis," SAI technical memorandum to D. Finkleman and J. Stregack dated September 25, 1979.

STATUS:

Operational Currently?: Yes - but limited.

Under Modification?: Yes

Purpose(s): Under development. The intent is to model the entire optical path to the calorimeter at CTS (including aerowindow and beam path conditioning ducts).

Ownership?: Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 175/NOS

TRANSPORTABLE?: Probably

Machine Dependent Restrictions: Line printer, disc storage.

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: ~1400

* Chemical Laser Scaling-Law Gain Model

CODE NAME: CLSLGM

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region ✓ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region 128 X 128		✓
Annular Region		

FIELD SYMMETRY RESTRICTIONS?: ___

MIRROR SHAPE(S) ALLOWED (√):
Square ✓ Circular ✓ Strip ___
Rectangular ✓ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)		

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison ___ Field Comparison ✓
Other Monitor rms change over crosshair*

ACCELERATION ALGORITHMS USED? Yes
Technique Field and/or gain averaging.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring): ___ Reverse TW ___

BRANCH (√): Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ___ Telescopes ✓
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors: *
Spatial Filters: ___ Gratings: *
Other Elements: Transmission functions only developed for DM and grating.*

GAIN MODELS (√): Bare Cavity Only: ✓
Simple Saturated Gain: ✓ Detailed Gain: ✓+

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ___ Decentration ___
Aberrations/Thermal Distortions:
Arbitrary ___
Selected (specify): ___
Reflectivity Loss ✓
Output Coupler Edges: Rolled ✓
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ✓
Gas Absorption in "gain" model.
Overlapped Beams ✓
Other ___

FAR-FIELD MODELS (√): Beam Steering Removal ___
Optimal Focal Search ___ Beam Quality ✓
Other ___

KINETICS

GAIN REGION MODELED (√): None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ **CW:** ___ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

^{Y}X	F	Cl	Br	I
H				
D				

Cold ($F + H_2$): ___
Hot ($H + F_2$): ___ Chain ($F + H_2$ & $H + F_2$) ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T ___
V-R ___
V-V ___
Other ___
Single Line Model (√) ___
Multiline Model (√) ___
Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM: ___

FLUID GRID DIMENSION (√): 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√):
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√):
Premixed ___ Mixing: ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√):
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

*on optic axis

*Not presently in code. +Empirical fit to BLAZER predictions.

CODE NAME: CROQ*

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models HSURIA and Ring Resonator with mode rotation. Is intended to be a resonator design code for maximizing focusability and power of output beam as a function of gain generator and resonator parameters.

ASSESSMENT OF CAPABILITIES: Constant or variable magnification non-everting waxicon with arbitrary offset angle. Full OPD matrix calculation. Tip flux unloading capability. Spherically diverging, converging, or collimated compact leg beam with capability to adjust ID/OD ratio (bifocal property of axicon) of output beam independent of resonator magnification. Models arbitrary tilt, decentation, misfigure, and thermal distortion of all elements. Models arbitrary number of struts.

ASSESSMENT OF LIMITATIONS: Planned additions: reflaxicon option, sparse OPD matrix calculation with interpolation, decomposition of OPD matrix into components amenable to convolution, integral annular leg treatment with introduction of FFT annular leg propagation, two or more gain sheets, polarization (vector) code.

OTHER UNIQUE FEATURES: User manuals planned; well commented listings (proprietary), available from TRW or AFWL; resonator geometrics modeled - HSURIA and ring resonator with mode rotation and axicon tip flux unloading; exp. gain, CL11, or HWN modeling.

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: RI/1162, One Space Park Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): Annular Laser Modes Studies Final Report (axicon theory, aligned and misaligned); other documentation planned.

STATUS:

Operational Currently?: Bare cavity version.

Under Modification?: Yes

Purpose(s): Add SLIM gain model (currently being implemented at AFWL). Thermal aberrations being coded.

Ownership?: Government

Proprietary?: Yes for ALPHA competition.

MACHINE/OPERATING SYSTEM (on which installed): Cyber 176 (CDC)

TRANSPORTABLE?: CDC Only

Machine Dependent Restrictions: CDC only (may have to recode permanent disk file management and core size adjustment compass routines for installation other than AFWL.)

SELF-CONTAINED?: No

Other Codes Required (name, purpose): IMSLIB routines for eigenvalue calculation; DISSPLA for 2D, 3D, and/or contour plots, VIINT, KBLIMP, ALFA for nozzle exit conditions.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	70K without	10
Typical Job:	DISPLA, 140K	210
Large Job:	with DISPLA	2000

Approximate Number of FORTRAN Lines: 10500 (11213 cards)

*Cylindrical Resonator Optical Quality

CODE NAME: CROQ

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	✓
Annular Region	✓	✓

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular ✓ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed Single Resonator Geometry ___
Fixed Multiple Resonator Geometries ✓
Modular Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		✓
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)	✓	

Other (specify) ___

CONVERGENCE TECHNIQUE (√):
Power Comparison ✓ Field Comparison ___
Other ___

ACCELERATION ALGORITHMS USED? No
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ✓
Other ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ___

BRANCH (√): Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ___ Spherical Mirrors ✓
Cylindrical Mirrors ___ Telescopes ___
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	✓	
Linear		
Parabola-Parabola		
Variable Cone Offset	✓	
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements Bifocal axicon, cone or corner reflector back elements.

GAIN MODELS (√): Bare Cavity Only ___
Simple Saturated Gain ___ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ✓
Selected (specify) ___
Reflectivity Loss ✓
Output Coupler Edges Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ✓
Gas Absorption ___
Overlapped Beams ✓
Other Single skin at rear element.*

FAR-FIELD MODELS (√): Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ___

KINETICS

GAIN REGION MODELED (√):
Compact Region ___ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region CY Annular Region CY

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region	✓	✓	✓*

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? Yes* Flow Direction? Yes

PULSED ___ **CW** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
{X + Y_2 YX + Y}
{Y + X_2 YX + X}

X	F	Cl	Br	I
H	✓			
D	✓			

Cold (F + H_2) ✓
Hot (H + F_2) ___ Chain (F + H_2 & H + F_2) ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ✓
V-R ___
V-V ✓
Other RR (ACLOS rot. noneq. to come)

Single Line Model (√) ___
Multiline Model (√) ✓

Assumed Rotational Population Distribution State (√)
Equilibrium ✓ Nonequilibrium Planned

Number of Laser Lines Modeled 24
Source of Rate Coefficients Used in Code N. Cohen

LINE PROFILE MODELS (√)
Doppler Broadening ✓
Collisional Broadening ✓
Other (specify) Operation at line center

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)**
Cylindrical, Radially Flowing ✓
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM CY

FLUID GRID DIMENSION (√) 1D ✓ 2D ___ 3D ___

FLOW FIELD MODELED (√)
Laminar ___ Turbulent ___
Other Scheduled mixing.

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ✓
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ✓
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ✓ SF_6 ___
Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED He, N_2, CF_4

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) Scheduled three stream: fuel, oxidant, mixed.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) Nonresonant and wake OPD index effects planned.

*Upgrading to two skins.

*With 2 + skin upgrad.

CODE NAME: DENTAL

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Laser kinetics calculations with strip unstable resonator.

ASSESSMENT OF CAPABILITIES: Kinetics which can be selected are CO_2, HF/DF, and KRF.

ASSESSMENT OF LIMITATIONS: One transverse dimension.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: Capt. Ted Salvi Phone: (505) 844-0721

Organization: AFWL/ALR

Address: Kirtland AFB, New Mexico 87115

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): T, U, RP: none

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Government (AFWL)

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC

TRANSPORTABLE?:

Machine Dependent Restrictions: FFT is machine language.

SELF-CONTAINED?:

Other Codes Required (name, purpose)

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job		
Typical Job		
Large Job		

Approximate Number of FORTRAN Lines

CODE NAME: DENTAL

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	
Annular Region		

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√)
Square ___ Circular ___ Strip ✓
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ___
Fixed Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging	✓	
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Trapezoidal

CONVERGENCE TECHNIQUE (√):
Power Comparison ✓ Field Comparison ✓
Other ___

ACCELERATION ALGORITHMS USED? No
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√): Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ✓ Spherical Mirrors ___
Cylindrical Mirrors ✓ Telescopes ___
Scraper Mirrors: ___

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ___
Simple Saturated Gain ___ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ✓ Decentration ___
Aberrations/Thermal Distortions
Arbitrary: ___
Selected (specify): Intensity map
Reflectivity Loss: ✓
Output Coupler Edges: Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ✓
Gas Absorption ✓
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√): Beam Steering Removal ___
Optimal Focal Search ___ Beam Quality ✓
Other: Atmospheric effects

KINETICS

GAIN REGION MODELED (√):
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region	✓		
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ✓ CW ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$
Cold ($F + H_2$) ✓

Y^X	F	Cl	Br	I
H	✓			
D	✓			

Hot ($H + F_2$) ___ Chain ($F + H_2$ & $H + F_2$) ___
Other (specify) CO_2, KrF

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ___
V-R ___
V-V ___
Other ___

Single Line Model (√) ✓
Multiline Model (√) ___

Assumed Rotational Population Distribution State (√)
Equilibrium ✓ Nonequilibrium ___

Number of Laser Lines Modeled 1

Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify): ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical Radially Flowing ___
Rectangular Linearly Flowing ✓
Other ___

COORDINATE SYSTEM Cart. strip.

FLUID GRID DIMENSION (√): 1D ✓ 2D ___ 3D ___

FLOW FIELD MODELED (√):
Laminar ✓ Turbulent ___
Other ___

BASIC MODELING APPROACH (√):
Premixed ✓ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√):
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√):
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ✓
Other (specify) ___

CODE NAME: DESALE-5

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculation of CW and Pulsed Chemical Laser Performance.

ASSESSMENT OF CAPABILITIES: Calculates solutions to coupled fluid dynamic, chemical kinetic and radiation transport equations for CW and pulsed chemical lasers. Utilizes comprehensive model of chemical kinetics and includes treatment of base relief and nozzle boundary layer effects.

ASSESSMENT OF LIMITATIONS: Restricted to Fabry-Perot cavity (although ad hoc technique for first order correction for curved mirrors has been included). Uses scheduled mixing model to treat mixing phenomena (although mixing rate is determined locally at each downstream station according to local flow properties). Restricted to rotational equilibrium.

OTHER UNIQUE FEATURES: Individual vibration levels treated as separate species; models effect of blockage (base relief).

ORIGINATOR/KEY CONTACT:

Name: M. Epstein Phone: (213) 648-6861

Organization: Aerophysics Laboratory, The Aerospace Corporation

Address: P.O. Box 92957, Los Angeles, California 90009

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) "Desale-5: A Comprehensive Scheduled Mixing Model for CW Chemical Lasers." Aerospace Corporation Rpt. SAMSO-TR-79-31, May 1, 1979. M. Epstein; (U) "The Resale Chemical Laser Computer Program." Aerospace Corporation Rpt. SAMSO-TR-75-60, W.D. Adams, E.B. Turner, J.F. Holt, D.G. Sutton, and H. Mirels, February 20, 1975.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Aerospace Corporation

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	146K	20
Typical Job:	146K	40
Large Job:	146K	60

Approximate Number of FORTRAN Lines: Overlay

CODE NAME: DESALE-5

OPTICS

BASIC TYPE (✓):
Physical Optics ____ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (✓):
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (✓):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (✓):
Square ____ Circular ____ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (✓):
Fixed, Single Resonator Geometry ✓
Fixed, Multiple Resonator Geometries ____
Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (✓):
Power Comparison ____ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? ____
Technique: ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓):
Prony ____
Other ____

None

RESONATOR TYPE (✓): Standing Wave ____
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (✓): Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (✓):
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (✓): Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (✓):
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ____
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (✓):
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR-FIELD MODELS (✓): Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (✓):
Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region ____

KINETICS GRID DIMENSIONALITY (✓):

	1D	2D	3D
Compact Region	✓		
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ____ Flow Direction? ✓

PULSED: ✓ CW: ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (✓):
$X + Y_2 \rightarrow YX + Y$
$Y + X_2 \rightarrow YX + X$

X	F	Cl	Br	I
H	✓			
D	✓			

Cold ($F + H_2$): ✓
Hot ($H + F_2$): ✓ Chain ($F + H_2$ & $H + F_2$): ✓
Other (specify): ____

ENERGY TRANSFER MODES MODELED (✓): Reference
V-T ✓ See rate coefficient reference
V-R ____
V-V ✓ See rate coefficient reference
Other ____

Single Line Model (✓) ✓ *
Multiline Model (✓) ____
Assumed Rotational Population Distribution State (✓)
Equilibrium ✓ Nonequilibrium ____
Number of Laser Lines Modeled 9
Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (✓)
Doppler Broadening ____
Collisional Broadening ____
Other (specify) Voight function (includes Doppler and collisional broadening).

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (✓):
Cylindrical, Radially Flowing ✓
Rectangular, Linearly Flowing ✓
Other Rectangular + varging area due to shrouds.

COORDINATE SYSTEM: Cartesian

FLUID GRID DIMENSION (✓): 1D ✓ 2D ____ 3D ____

FLOW FIELD MODELED (✓):
Laminar ✓ Turbulent ✓
Other ____

BASIC MODELING APPROACH (✓):
Premixed ____ Mixing ✓ (scheduled mass addition)
Other (specify) ____
References for Approach Used ____

THERMAL DRIVER MODELED (✓):
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (✓):
F_2 ✓ SF_6 ✓
Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED He, Ar, N_2, others possible.

MODELS EFFECTS ON MIXING RATE DUE TO (✓):
Nozzle Boundary Layers ✓ Shock Waves ____
Prereactions (thermal blockage) ✓ Turbulence ✓
Other (specify) Rate of mass addition to mixing zone calculated as part of solution using local values of variables.

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓):
Media Index Variations ____
Other (specify) ____

*Lasing on only one transition between prs of vibrational levels.

CODE NAME: ELNWD2

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute transverse eigenmodes of bare annular resonators and later add simple gain.

ASSESSMENT OF CAPABILITIES: Mode loss, frequency, mode shape, and optical quality versus equivalent Fresnel number, magnification, and fractional length that is compacted.

ASSESSMENT OF LIMITATIONS: Linear mirrors; low azimuthal modes; geometry. Extensions are difficult $N_{EQ} > 1$ due to asymptotic Fresnel approximation.

OTHER UNIQUE FEATURES: Can model HSURIA and compact unstable confocal resonator.

ORIGINATOR/KEY CONTACT:

Name: John Ellinwood Phone: (213) 648-7391

Organization: Aerospace Corporation

Address: Box 92957, Los Angeles, California 90009

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) To be submitted to JOSA; (U) none; (listings) custom available; (RP) see literature on asymptotic methods.

STATUS:

Operational Currently?: No

Under Modification?: Under development

Purpose(s):

Ownership?: Aerospace Corporation

Proprietary?: Distribution controlled by USAF.

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 76/172

TRANSPORTABLE?: No guarantee

Machine Dependent Restrictions: Plot routine

SELF-CONTAINED?: No

Other Codes Required (name, purpose): Special functions, IMSL

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	40K	5
Typical Job:	40K	5
Large Job:	40K	5

Approximate Number of FORTRAN Lines: 400

CODE NAME: ELNWD2

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region cy Annular Region cy

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular ✓ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ✓
Fixed, Multiple Resonator Geometries ___
Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)		

Other (specify) Analytic solution of integral equation, Fresnel integrals appear explicity

CONVERGENCE TECHNIQUE (√):
Power Comparison ___ Field Comparison ___
Other Analytic convergence as per Horwitz

ACCELERATION ALGORITHMS USED? None
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: Polynomial roots
Other ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√): Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ___ Spherical Mirrors ✓
Cylindrical Mirrors ___ Telescopes ___
Scraper Mirrors ___

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear	✓	✓
Parabola-Parabola		
Variable Cone Offset:		
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ✓
Simple Saturated Gain Soon Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ___ Decentration: ___
Aberrations/Thermal Distortions:
Arbitrary: ___
Selected (specify): ___
Reflectivity Loss: ✓
Output Coupler Edges: Rolled: ___
Serrated: ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation: ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√): Beam Steering Removal ___
Optimal Focal Search ___ Beam Quality Soon
Other ___

KINETICS

GAIN REGION MODELED (√) None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ **CW** ___ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$\left\{ \begin{matrix} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{matrix} \right\}$

	F	Cl	Br	I
H				
D				

Cold (F + H_2): ___
Hot (H + F_2): ___ Chain (F + H_2 & H + F_2): ___
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ___
V-R ___
V-V ___
Other ___
Single Line Model (√) ___
Multiline Model (√) ___
Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)** None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___
FLUID GRID DIMENSION (√) 1D ___ 2D ___ 3D ___
FLOW FIELD MODELED (√):
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___
DILUENTS MODELED ___
MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Preractions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

CODE NAME: GASSER

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Inviscid flow code using the method of characteristics and accounts for heat release. It is used for cavity flows with heat release defining shroud contours flow conditions at end of cavity, etc.

ASSESSMENT OF CAPABILITIES: It can calculate mean flow parameters in the laser cavity and the variations normal to the optical axis, resulting in optical path difference fields.

ASSESSMENT OF LIMITATIONS: It does not do the laser mixing problem and the heat release is an input.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: D. Haflinger and P. Lohr Phone: (213) 536-1624

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication):

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: TRW

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: No

Other Codes Required (name, purpose): Combustor (GLAD) generates inputs to GASSER at the cavity entrance.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	50K	25
Large Job:		

Approximate Number of FORTRAN Lines: 1000

CODE NAME: GASSER

OPTICS

BASIC TYPE (√) None
Physical Optics ____ Geometrical ____
FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ____ Vector ____
COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region ____ Annular Region ____
TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____
MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ____ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____
CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ____
Fixed, Multiple Resonator Geometries ____
Modular, Multiple Resonator Geometries ____
PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)		

Other (specify) ____
CONVERGENCE TECHNIQUE (√)
Power Comparison ____ Field Comparison ____
Other ____
ACCELERATION ALGORITHMS USED? ____
Technique ____
MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ____
Other ____

None

RESONATOR TYPE (√): Standing Wave ____
Traveling Wave (Ring) ____ Reverse TW ____
BRANCH (√): Positive ____ Negative ____
OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____
GAIN MODELS (√): Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ____
BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ____
Output Coupler Edges Rolled ____
Serrated ____ Other ____
LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____
FAR-FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (√): None
Compact Region ____ Annular Region ____
COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____
KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ____ Flow Direction? ____
PULSED: ____ CW: ____ KINETICS MODELED
CHEMICAL PUMPING REACTIONS MODELED (√):
$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$: ____
Hot $(H + F_2)$ ____ Chain $(F + H_2 \& H + F_2)$ ____
Other (specify) ____
ENERGY TRANSFER MODES MODELED (√): Reference
V-T ____
V-R ____
V-V ____
Other ____
Single Line Model (√) ____
Multiline Model (√) ____
Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium ____
Number of Laser Lines Modeled ____
Source of Rate Coefficients Used in Code ____
LINE PROFILE MODELS (√)
Doppler Broadening ____
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing √
Other ____
COORDINATE SYSTEM: Ca
FLUID GRID DIMENSION (√): 1D ____ 2D √ 3D ____
FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other Inviscid with scheduled heat release.
BASIC MODELING APPROACH (√):
Premixed √ Mixing ____
Other (specify) ____
References for Approach Used Leipman and Roshko "Elements of Gas Dyn;" Shapiro "Dynamics and Thermo of Compressible Flow"
THERMAL DRIVER MODELED (√)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____
F-ATOM DISSOCIATION FROM (√)
F_2 ____ SF_6 ____
Other (specify) ____
F-ATOM CONCENTRATION DETERMINED FROM MODEL? No
DILUENTS MODELED ____
MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____
MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

CODE NAME GCAL

CODE TYPE Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE To provide extremely efficient single-line gain algorithm which is anchored to available data base for nozzle being studied. Used with SAIGD.

ASSESSMENT OF CAPABILITIES Principally designed to analyze source flow nozzles but can also be applied to conventional 2-D slit nozzles.

ASSESSMENT OF LIMITATIONS

OTHER UNIQUE FEATURES The gain algorithm is a simplification of a full gasdynamic/kinetics code. A series of gasdynamic and kinetic parameter profiles are passed from the full code to the gain algorithm in the form of a data file. The gain algorithm then solves the lasing specie equations for that gasdynamic/kinetic field with an imposed intensity profile (see SAIGD).

ORIGINATOR/KEY CONTACT
Name Kerry E. Patterson Phone (494) 955-2663
Organization Science Applications, Inc.
Address 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION (T - Theory, U - User, RP - Relevant Publication) (T) HF Laser Subsystem Technology Assessment (DARPA Interim Report) Science Applications, Inc., Atlanta, Georgia, July, 1979, Section 3.

STATUS
Operational Currently? Yes
Under Modification? Yes
Purpose(s) Extend to multi-line capability.

Ownership? U.S. Government
Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed) Cyber 175

TRANSPORTABLE? Yes
Machine Dependent Restrictions None

SELF-CONTAINED? No
Other Codes Required (name, purpose) SAIGD - SAI gasdynamics code generates gasdynamic field variables as input to this code.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job	Negligible	0.1
Large Job		

Approximate Number of FORTRAN Lines 75

CODE NAME GCAL

OPTICS

BASIC TYPE (√)
Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____
MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ____ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ____
Fixed Multiple Resonator Geometries ____
Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardner Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)
Power Comparison ____ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? ____
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave ____
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (√): Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ____
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (√)
Compact Region √ Annular Region √

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region CY

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region		√	
Annular Region		√	

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? Yes* Flow Direction? Yes

PULSED ____ CW √ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$\left\{ \begin{array}{l} X + Y_2 \quad YX + Y \\ Y + X_2 \quad YX + X \end{array} \right\}$

X	F	Cl	Br	I
H	√			
D	√			

Cold $(F + H_2)$ √
Hot $(H + F_2)$ √ Chain $(F + H_2 \& H + F_2)$ √
Other (specify) ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T √ Cohen & Bott (1976)
V-R ____
V-V ____
Other ____

Single Line Model (√) √(with multi-line corrections)
Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____
Source of Rate Coefficients Used in Code Cohen & Bott (1976)

LINE PROFILE MODELS (√)
Doppler Broadening √
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√):
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM ____
FLUID GRID DIMENSION (√): 1D ____ 2D ____ 3D ____
FLOW FIELD MODELED (√):
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (√)
Premixed ____ Mixing ____
Other (specify) ____
References for Approach Used ____

THERMAL DRIVER MODELED (√):
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (√):
F_2 ____ SF_6 ____
Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____
DILUENTS MODELED: ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

* with multiple gain sheets

CODE NAME: GENRING

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model chemical laser ring resonators utilizing linear and non-linear reflecting axicons to produce an annular gain region; to study and trade off ring resonator candidates; to study effects of spatial filtering on mode control; to study the concept of (scraper) aperture self-imaging.

ASSESSMENT OF CAPABILITIES: Models bare and loaded unstable ring resonators of aligned circulary-shaped optics which employ a pair of similar reflecting axicons. Models positive and negative branch resonators. Models simple gain. Uses Fresnel-Kirchhoff propagation. Models far-field performance. 2-D plots.

ASSESSMENT OF LIMITATIONS: Cavity fields are assumed to be circularly symmetric; this is a 2-D code.

OTHER UNIQUE FEATURES: Models positive and negative branch P-P waxicon (reflaxicon)/P-P waxicon (reflaxicon) ring with or without offset. Bare or loaded. Also models linear waxicon (reflaxicon) combinations. Easily modified to model ring resonators without axicons.

ORIGINATOR/KEY CONTACT:

Name: Carl M. Wiggins Phone: (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road S.E., Albuquerque, New Mexico 87106

AVAILABLE DOCUMENTATION (T - Theory, U - User, RP - Relevant Publication): (T) and (U) "GENRING: A Computer Code for Modeling Cylindrical Unstable Ring Resonators With Internal Reflecting Axicons" BDM/TAC-79-152-TR, The BDM Corporation, May 1, 1979; listings available from AFWL/ALR.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Government (AFWL/ALR)

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600/7600

TRANSPORTABLE?: Yes, except for plot routines

Machine Dependent Restrictions: Uses AFWL plot library METALIB.

SELF-CONTAINED?: No

Other Codes Required (name, purpose): Uses AFWL plot library METALIB.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	200K	5
Typical Job	200K	15
Large Job	200K	30

Approximate Number of FORTRAN Lines: 1700

CODE NAME: GENRING

OPTICS

BASIC TYPE (√)
Physical Optics √ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar √ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	√	
Annular Region	√	

FIELD SYMMETRY RESTRICTIONS? Yes

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular √ Strip √
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries √
Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms	√	√
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Midpoint rule

CONVERGENCE TECHNIQUE (√):
Power Comparison √ Field Comparison ___
Other ___

ACCELERATION ALGORITHMS USED? None
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√): Standing Wave ___
Traveling Wave (Ring) √ Reverse TW ___

BRANCH (√): Positive √ Negative √

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors √ Spherical Mirrors √
Cylindrical Mirrors ___ Telescopes √
Scraper Mirrors √

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear	√	√
Parabola-Parabola	√	√
Variable Cone Offset	√	√
Other (specify)		

Deformable Mirrors ___
Spatial Filters √ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only √
Simple Saturated Gain √ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ___ Decentration ___
Aberrations/Thermal Distortions
Arbitrary ___
Selected (specify) Can mod for circular symmetric distortions.
Reflectivity Loss ___
Output Coupler Edges: Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR FIELD MODELS (√): Beam Steering Removal ___
Optimal Focal Search √ Beam Quality √
Other ___

KINETICS

GAIN REGION MODELED (√): None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ CW: ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$

	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T ___
V-R ___
V-V ___
Other ___

Single Line Model (√) ___
Multiline Model (√) ___

Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___
FLUID GRID DIMENSION (√): 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√):
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√):
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√):
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Preeactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

CODE NAME: GIM

CODE TYPE: Gasdynamics Code

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: General Interpolation Method (GIM) is used for laser cavity and nozzle analysis. Used for external and internal flows.

ASSESSMENT OF CAPABILITIES: Multidimensional 2-D, 3-D viscous, diffusing flows; time-dependent. Will eventually combine this capability with the chemical kinetics of ALFA and APACHE.

ASSESSMENT OF LIMITATIONS: Simplified diffusion.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: D. W. Lankford Phone: (505) 844-9836

Organization: Air Force Weapons Laboratory

Address: AFWL/ARAC, Kirtland AFB, New Mexico 87117

AVAILABLE DOCUMENTATION: (T Theory, U = User, RP Relevant Publication): (T) (U) To become available after modifications are completed.

STATUS:

Operational Currently?: Yes

Under Modification?: Yes, from December 1979 until January 1981.

Purpose(s): Add all chemistry and laser physics capabilities of ALFA.

Ownership?: Lockheed Space and Missiles; USAF after modificaticns complete.

Proprietary?: Yes, while under development by Lockheed.

MACHINE/OPERATING SYSTEM (on which installed): CDC 176, Star, Cray.

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: No

Other Codes Required (name, purpose): Three modules: geometry mesh, code assembly, operational assembly.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	100K CM/500K ECS	1-2 hours
Large Job:	150K CM/1000K ECS	2+ hours

Approximate Number of FORTRAN Lines:

CODE NAME: GIM

OPTICS

None

BASIC TYPE (√) None

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ____ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed, Single Resonator Geometry ____

Fixed, Multiple Resonator Geometries ____

Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ____

Other ____

RESONATOR TYPE (√) Standing Wave ____

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ____ Spherical Mirrors ____

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (√) None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ CW ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ X + Y_2 \quad YX + Y \right\}$

$\left\{ Y + X_2 \quad YX + X \right\}$

Y \ X	F	Cl	Br	I
H				
D				

Cold ($F + H_2$) ____

Hot ($H + F_2$) ____ Chain ($F + H_2$ & $H + F_2$) ____

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V-T ____

V-R ____

V-V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)

Cylindrical, Radially Flowing √

Rectangular, Linearly Flowing √

Other ____

COORDINATE SYSTEM Ca and cy

FLUID GRID DIMENSION (√) 1D √ 2D √ 3D ____

FLOW FIELD MODELED (√)

Laminar √ Turbulent √

Other Recirculating

BASIC MODELING APPROACH (√)

Premixed ____ Mixing √

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor √

Shock Tube ____ Resistance Heater ____

Other ____

F-ATOM DISSOCIATION FROM (√)

F_2 √ SF_6 ____

Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED He

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers √ Shock Waves √

Prereactions (thermal blockage) ____ Turbulence √

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME: GLADY

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: General laser analysis to calculate average flow properties in nozzles and in cavity.

ASSESSMENT OF CAPABILITIES: With general input quantities such as bulk heat loss and flow conditions, average flow conditions are calculated accurately. Two nozzle flow options are included, for high and moderate Reynold's numbers.

ASSESSMENT OF LIMITATIONS: Detailed flow conditions cannot be predicted. Cavity chemistry is also done by bulk procedures.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: R. Hughes/D. Haflinger/H. Behrens Phone: (213) 536-2757

Organization: TRW DSSG

Address: R1/1038, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T – Theory, U – User, RP – Relevant Publication): (T) None; listings proprietary.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: TRW

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC 174

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	44K	15
Typical Job	44K	15
Large Job	44K	15

Approximate Number of FORTRAN Lines 5000

CODE NAME: GLADV

OPTICS

BASIC TYPE (√) None

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√):

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√):

Square ____ Circular ____ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√):

Fixed, Single Resonator Geometry ____

Fixed, Multiple Resonator Geometries ____

Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√):

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):

Prony ____

Other ____

RESONATOR TYPE (√): None

Standing Wave ____

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√): Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):

Flat Mirrors ____ Spherical Mirrors ____

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√): Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges: Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√):

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR-FIELD MODELS (√): Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (√): None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{\begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array}\right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold (F + H_2): ____

Hot (H + F_2): ____ Chain (F + H_2 & H + F_2) ____

Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference

V-T ____

V-R ____

V-V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√):

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√):

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)

Cylindrical, Radially Flowing ____

Rectangular, Linearly Flowing √

Other ____

COORDINATE SYSTEM Ca

FLUID GRID DIMENSION (√) 1D √ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar √ Turbulent ____

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing √ (bulk)

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F-ATOM DISSOCIATION FROM (√)

F_2 √ SF_6 ____

Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? no

DILUENTS MODELED He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME GOPWR

CODE TYPE: Optics, Kinetics and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculational tool to study the performance of CW chemical lasers and the interaction with the gain medium.

ASSESSMENT OF CAPABILITIES: Uses geometric optics and quasi-one-dimensional aerokinetics. Useful for parameter studies to indicate the importance of design parameters on laser performance.

ASSESSMENT OF LIMITATIONS: Limited to HSURIA geometry only unless modified.

OTHER UNIQUE FEATURES: Resonator geometries modeled: HSURIA, reflaxicon beam compactors.

ORIGINATOR/KEY CONTACT:

Name: J. K. Hunting/T. T. Yang Phone: (213)884-2370

Organization: Rocketdyne

Address: 6633 Canoga Avenue, Canoga Park, California

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) Rocketdyne Internal Letter G-SL-77-509, October 5, 1977; (U) Rocketdyne Internal Letter G-0-78-937, January 24, 1978.

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Rocketdyne

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 176 NOS BE

TRANSPORTABLE?: No

Machine Dependent Restrictions: Uses CDC Fortran extended features, uses CDC LCM.

SELF-CONTAINED?:

Other Codes Required (name, purpose): DISSPLA Plot library.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	16K/15K LCM	10 sec/iteration
Typical Job	16K/15K LCM	10 sec/iteration
Large Job	16K/15K LCM	10 sec/iteration

Approximate Number of FORTRAN Lines: 3200

CODE NAME: GOPWR

OPTICS

BASIC TYPE (√)
Physical Optics ____ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region cy Annular Region cy

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? Axisymmetric

MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ✓ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)
Fixed: Single Resonator Geometry ✓
Fixed: Multiple Resonator Geometries ____
Modular: Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Geometric optics

CONVERGENCE TECHNIQUE (√)
Power Comparison ✓ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? No
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ✓ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ____ Telescopes ✓
Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		✓
Variable Cone Offset		✓
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements: ____

GAIN MODELS (√): Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions:
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ✓
Output Coupler Edges: Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR-FIELD MODELS (√): Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (√):
Compact Region ____ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region cy Annular Region cy

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region	✓		

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2$ YX + Y
$Y + X_2$ YX + X

X	F	Cl	Br	I
H	✓			
D	✓			

Cold ($F + H_2$): ✓
Hot ($H + F_2$): ✓ Chain ($F + H_2$ & $H + F_2$) ✓
Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T ✓ Cohen
V-R ____
V-V ✓ Cohen
Other ____

Single Line Model (√) ✓
Multiline Model (√) ✓

Assumed Rotational Population Distribution State (√)
Equilibrium ✓ Nonequilibrium ✓

Number of Laser Lines Modeled ≤ 12

Source of Rate Coefficients Used in Code Aerospace - N. Cohen

LINE PROFILE MODELS (√):
Doppler Broadening ✓
Collisional Broadening ✓
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical: Radially Flowing ✓
Rectangular: Linearly Flowing ✓
Other ____

COORDINATE SYSTEM cylindrical

FLUID GRID DIMENSION (√) 1D ✓ 2D ____ 3D ____

FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other Scheduled mixing.

BASIC MODELING APPROACH (√)
Premixed ____ Mixing ✓
Other (specify) ____

References for Approach Used ALOS Final Report

THERMAL DRIVER MODELED (√):
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other Not modeled

F-ATOM DISSOCIATION FROM (√):
F_2 ✓ SF_6 ✓
Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? *

DILUENTS MODELED: He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ✓ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) Trip

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ✓
Other (specify) ____

*Uses equilibrium thermochemistry.

CODE NAME: GURDM

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Originally designed to model Pratt's Intracavity Adaptive Optics experiments. Models bare cavity compact beam resonators with circular end mirrors and one or two internal deformable mirrors. A far-field code includes external deformable mirror, tilt removal, optimum focus, etc.

ASSESSMENT OF CAPABILITIES: Full 3-D tilt and decentrations of all mirrors; arbitrary deformations on all mirrors; arbitrary turning angles at internal deformable mirrors. 2-D and 3-D plots.

ASSESSMENT OF LIMITATIONS: Usual paraxial requirements; restrictions on peak deformations of turning mirrors, machine and cost limitations for large problems.

OTHER UNIQUE FEATURES: Models any two-mirror stable or unstable compact beam resonator with one or two deformable turning mirrors intracavity, one deformable turning mirror extracavity.

ORIGINATOR/KEY CONTACT:

Name: Thomas R. Ferguson or Guy T. Worth Phone: (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road S.E., Albuquerque, New Mexico 87106

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) (U) General Unstable Resonator with Deformable Mirrors (Program GURDM), T. R. Ferguson et al, The BDM Corporation, BDM/TAC-79-193-TR, March 31, 1979.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Government (AFWL/ALR).

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6000, 7000, 176.

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: CDC I/O, size restrictions.

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job		
Large Job		

Approximate Number of FORTRAN Lines:

CODE NAME: GURDM

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region CY Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	✓*
Annular Region		

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular ✓ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ___
Modular, Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature	✓	
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√)
Power Comparison ✓ Field Comparison ___
Other ___

ACCELERATION ALGORITHMS USED? None
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√): Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ___ Telescopes ___
Scraper Mirrors ___

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ✓
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ✓
Simple Saturated Gain ✓ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ✓
Selected (specify) Shape set by Zernike coefficients input.
Reflectivity Loss ___
Output Coupler Edges: Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other External deformable mirror.

KINETICS

GAIN REGION MODELED (√) None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED ___ **CW** ___ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√)
$\left\{ X + Y_2 \quad YX + Y \right\}$
$\left\{ Y + X_2 \quad YX + X \right\}$

Y/X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ___
V-R ___
V-V ___
Other ___
Single Line Model (√) ___
Multiline Model (√) ___
Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)** None
Cylindrical: Radially Flowing ___
Rectangular: Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___

FLUID GRID DIMENSION (√) 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√)
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

*Azimuthal Fourier expansion.

CODE NAME: HFGOPWR

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculational tool to study the performance of CW chemical lasers and the interaction with the gain medium.

ASSESSMENT OF CAPABILITIES: Uses geometric optics and quasi-one-dimensional aerokinetics. Useful for parameter studies to indicate the importance of design parameters on laser performance.

ASSESSMENT OF LIMITATIONS: Limited to HSURIA geometry only unless modified.

OTHER UNIQUE FEATURES: Resonator geometries modeled: HSURIA, reflaxicon beam compactors.

ORIGINATOR/KEY CONTACT:

Name: J. K. Hunting/T. T. Yang Phone: (213)884-2370

Organization: Rocketdyne

Address: 6633 Canoga Ave., Canoga Park, California

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) Rocketdyne Internal Letter G-SL-77-509, October 5, 1977; (U) Rocketdyne Internal Letter G-0-78-937, January 24, 1978.

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Rocketdyne

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 176 NOS BE.

TRANSPORTABLE?: No

Machine Dependent Restrictions: Uses CDC Fortran extended features, uses CDC LCM.

SELF-CONTAINED?:

Other Codes Required (name, purpose): DISSPLA Plot library.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	16K/15K LCM	10 sec/iteration
Typical Job	16K/15K LCM	10 sec/iteration
Large Job	16K/15K LCM	10 sec/iteration

Approximate Number of FORTRAN Lines 3200

CODE NAME: HFGOPWR

OPTICS

BASIC TYPE (√)
- Physical Optics ____ Geometrical √

FIELD (POLARIZATION) REPRESENTATION (√)
- Scalar √ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? Axisymmetric

MIRROR SHAPE(S) ALLOWED (√)
- Square ____ Circular √ Strip ____
- Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)
- Fixed Single Resonator Geometry √
- Fixed Multiple Resonator Geometries ____
- Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

- Other (specify) Geometric optics.

CONVERGENCE TECHNIQUE (√)
- Power Comparison √ Field Comparison ____
- Other ____

ACCELERATION ALGORITHMS USED? No
- Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
- Prony ____
- Other ____

RESONATOR TYPE (√): Standing Wave √
- Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√): Positive √ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):
- Flat Mirrors √ Spherical Mirrors √
- Cylindrical Mirrors: ____ Telescopes √
- Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary:		
Linear:		
Parabola-Parabola:		√
Variable Cone Offset:		√
Other (specify):		

- Deformable Mirrors: ____
- Spatial Filters: ____ Gratings ____
- Other Elements ____

GAIN MODELS (√): Bare Cavity Only ____
- Simple Saturated Gain ____ Detailed Gain √

BARE CAVITY FIELD MODIFIER MODELS (√)
- Mirror Tilt ____ Decentration ____
- Aberrations/Thermal Distortions
  - Arbitrary ____
  - Selected (specify) ____
- Reflectivity Loss √
- Output Coupler Edges: Rolled ____
  - Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
- Medium Index Variation ____
- Gas Absorption ____
- Overlapped Beams ____
- Other ____

FAR-FIELD MODELS (√): Beam Steering Removal ____
- Optimal Focal Search ____ Beam Quality ____
- Other ____

KINETICS

GAIN REGION MODELED (√)
- Compact Region ____ Annular Region √

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region CY Annular Region CY

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region	√		

GAIN REGION SYMMETRY RESTRICTIONS
- Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

Y^X	F	Cl	Br	I
H	√			
D	√			

- Cold $(F + H_2)$ √
- Hot $(H + F_2)$ √ Chain $(F + H_2$ & $H + F_2)$ √
- Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference
- V-T √ Cohen
- V-R ____
- V-V √ Cohen
- Other ____

Single Line Model (√) √

Multiline Model (√) √

Assumed Rotational Population Distribution State (√)
- Equilibrium √ Nonequilibrium √

Number of Laser Lines Modeled ≤ 12

Source of Rate Coefficients Used in Code Aerospace - N. Cohen

LINE PROFILE MODELS (√)
- Doppler Broadening √
- Collisional Broadening √
- Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
- Cylindrical Radially Flowing √
- Rectangular Linearly Flowing √
- Other ____

COORDINATE SYSTEM cylindrical

FLUID GRID DIMENSION (√) 1D √ 2D ____ 3D ____

FLOW FIELD MODELED (√)
- Laminar ____ Turbulent ____
- Other Scheduled mixing.

BASIC MODELING APPROACH (√)
- Premixed ____ Mixing √
- Other (specify) ____

References for Approach Used ALOS Final Report

THERMAL DRIVER MODELED (√)
- Arc Heater ____ Combustor ____
- Shock Tube ____ Resistance Heater ____
- Other Not modeled.

F-ATOM DISSOCIATION FROM (√)
- F_2 √ SF_6 √
- Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? *

DILUENTS MODELED He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√)
- Nozzle Boundary Layers √ Shock Waves ____
- Prereactions (thermal blockage) ____ Turbulence ____
- Other (specify) Trip

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
- Media Index Variations √
- Other (specify) ____

*Uses equilibrium thermochemistry.

CODE NAME HFOX

CODE TYPE Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Predict oscillator and amplifier performance for Sandia Lab's hydrogen flouride fusion laser program.

ASSESSMENT OF CAPABILITIES Can do HF pulsed oscillator and amplifier cases with longitudinal nonuniformities, plus volume-averaged oscillator calculations. Rotational nonequilibrium, hot-atom enhancement of hot and cold reaction rates, chain-terminating O_2 kinetics, amplified spontaneous emission, and transverse parasitic oscillations are allowed.

ASSESSMENT OF LIMITATIONS Initiation rate must be specified. Calculations which allow longitudinal nonuniformity require increasing amounts of computer time as pulse length increases. No optics in this code. Rotational relaxation limited to R-T. Difficult to add reactions to existing scheme.

OTHER UNIQUE FEATURES Hot-atom hot and cold rate enhancement; amplified spontaneous emission along optical axis included in amplifier calculations; amplifier input pulse detailed-spectral-time-history description allowed; transverse parasitic oscillations allowed in both oscillator and amplifier calculations.

ORIGINATOR/KEY CONTACT

Name James B. Moreno Phone (505) 264-4259

Organization Sandia Laboratories

Address 4212, Laser Projects Division, Kirtland AFB, New Mexico 87117

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication) (RP) AIAA paper 75-36 presented at AIAA 13th Aerospace Sciences Meeting, Pasadena, California, January 20, 1975, J. B. Moreno.

STATUS

Operational Currently? Yes

Under Modification? Not at present

Purpose(s)

Ownership? Sandia Laboratories/D.O.E.

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed) CDC 7600

TRANSPORTABLE? Not very, since not documented.

Machine Dependent Restrictions

SELF CONTAINED? Yes

Other Codes Required (name, purpose)

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		180
Typical Job	All jobs same: 150K	600
Large Job		1200

Approximate Number of FORTRAN Lines

CODE NAME: HFOX

OPTICS

None

BASIC TYPE (√) None
Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ____ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)
Fixed, Single Resonator Geometry ____
Fixed, Multiple Resonator Geometries ____
Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	[illegible]	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)
Power Comparison ____ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? ____
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave ____
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ____
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (√)
Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? √ Flow Direction? ____

PULSED √ **CW** ____ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

Y^X	F	Cl	Br	I
H	√			
D	√			

Cold $(F + H_2)$ √
Hot $(H + F_2)$ √ Chain $(F + H_2$ & $H + F_2)$ √
Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference
V T √ Aerospace Corp. compilations.
V R ____
V V √ Aerospace Corp. compilations.
Other ____

Single Line Model (√) ____
Multiline Model (√) √

Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium √

Number of Laser Lines Modeled 77*

Source of Rate Coefficients Used in Code Aerospace Corp.

LINE PROFILE MODELS (√)
Doppler Broadening √
Collisional Broadening √
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)** None
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (√)
Premixed ____ Mixing ____
Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F ATOM DISSOCIATION FROM (√)
F_2 ____ SF_6 ____
Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

*Variable dimension code.

CODE NAME IPAGOS

CODE TYPE Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Interactive version of POLYPAGOS; conduct geometric ray trace analysis of general optical systems; code subroutines can design nonlinear beam compactors of reflaxicon, waxicon, and noneverting waxicon designs.

ASSESSMENT OF CAPABILITIES Code can produce OPD and spot diagrams through systems containing spheres, conics, torics, diffraction gratings, axicons, and corner cubes. Code can take Fourier transform of field at output plane and generate far-field energy distributions. Can handle up to two deformable mirrors. Will map movement of a ray via multiple passes.

ASSESSMENT OF LIMITATIONS Has no physical optics capability internal to optical train; does not model resonators by iterative solution techniques.

OTHER UNIQUE FEATURES Resonator geometries modeled: HSURIA, compact unstable confocal, unstable P-P waxicon/linear waxicon negative branch ring with spatial filter.

ORIGINATOR/KEY CONTACT

Name: D. Mansell/C. Barnard/Kemp* Phone: (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road, S.E., Albuquerque, New Mexico 87106

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication) (T) "POLYPAGOS" Aerospace Report TR-0059(6311)-1; (T) "Beam Compactor Design and Fabrication Program," AFWL-TR-78-77; (T) "Geometry Ray Analyses of HSURIA Prototypes," BDM/TAC-79-151-TR; (U) POLYPAGOS Users Manual, Aerospace TR-0172(2311)-1; (U) AFWL-TR-78-77.

STATUS

Operational Currently? Yes

Under Modification? No

Purpose(s)

Ownership? AFWL

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed) CDC 6600/7600

TRANSPORTABLE? Yes

Machine Dependent Restrictions: Requires overlaying.

SELF-CONTAINED? Yes

Other Codes Required (name purpose)

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec CDC 7600)
Small Job		
Typical Job	120K	1 sec
Large Job		

Approximate Number of FORTRAN Lines: 8300

* TRW/DSSG, 1 Space Park, Redondo Beach, California

CODE NAME IPAGOS

OPTICS

BASIC TYPE (√)
Physical optics ____ geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ____ vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region Ca

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√)
Square ✓ Circular ✓ Strip ✓
Rectangular ✓ Elliptical ✓ Arbitrary No

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ____
Fixed Multiple Resonator Geometries ____
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)
Power Comparison ____ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? ____
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ✓

BRANCH (√) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ✓ Telescopes ✓
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	✓	✓
Linear	✓	✓
Parabola Parabola	✓	✓
Variable Cone Offset	✓	✓
Other (specify) Noneverting	✓	

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements Torics
Corner cubes

GAIN MODELS (√) Bare Cavity Only ✓
Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ____
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR-FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ✓
Other Isometric plotting

KINETICS

GAIN REGION MODELED (√) None
Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ CW ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)
$\left\{ X + Y_2 \quad YX + Y \right\}$
$\left\{ Y + X_2 \quad YX + X \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ____
Hot $(H + F_2)$ ____ Chain $(F + H_2 \& H + F_2)$ ____
Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference
V T ____
V R ____
V V ____
Other ____
Single Line Model (√) ____
Multiline Model (√) ____
Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium ____
Number of Laser Lines Modeled ____
Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)
Doppler Broadening ____
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (√)
Premixed ____ Mixing ____
Other (specify) ____
References for Approach Used ____

THERMAL DRIVER MODELED (√)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (√)
F_2 ____ SF_6 ____
Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

CODE NAME: KBLIMP

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Boundary layer analysis. Nonequilibrium Chemistry (KINETIC) Boundary Layer Integral Matrix Program (KBLIMP).

ASSESSMENT OF CAPABILITIES: Treats laminar and turbulent flows. Multicomponent and chemically reacting flows (including wall recombination) are analyzed.

ASSESSMENT OF LIMITATIONS: Must predetermine pressure gradient.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: H. Tong/ A.C. Buckingham/H.L. Morse Phone: (415) 964-3200

Organization: Aerotherm Division of ACUREX

Address: Mountain View, California

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication): (T) Nonequilibrium Chemistry Boundary Layer Integral Matrix Procedure, Aerotherm Report, UM7367. July 1973.

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Industry-wide code.

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600/7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: No

Other Codes Required (name, purpose): Codes required to generate pressure distribution.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	120K	300
Typical Job:	120K	1000
Large Job:	120K	2000

Approximate Number of FORTRAN Lines: 14000

CODE NAME: KBLIMP

OPTICS

BASIC TYPE (√) None

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ____ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry ____

Fixed Multiple Resonator Geometries ____

Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ____

Other ____

None

RESONATOR TYPE (√) Standing Wave ____

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):

Flat Mirrors ____ Spherical Mirrors ____

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√): Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (√): None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{ \begin{matrix} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{matrix} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold ($F + H_2$) ____

Hot ($H + F_2$) ____ Chain ($F + H_2$ & $H + F_2$) ____

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V-T ____

V-R ____

V-V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)

Cylindrical Radially Flowing ✓

Rectangular Linearly Flowing ✓

Other ____

COORDINATE SYSTEM General

FLUID GRID DIMENSION (√) 1D ____ 2D ✓ 3D ____

FLOW FIELD MODELED (√)

Laminar ✓ Turbulent ✓

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ✓

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F-ATOM DISSOCIATION FROM (√)

F_2 ✓ SF_6 ____

Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED He, N_2, etc.

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ✓ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ✓

Other (specify) Laminar

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME LAPU-2

CODE TYPE: Optics code

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculation of the propagation of a short pulse down a chain of laser amplifiers and absorbers including diffraction effects; cylindrical symmetry assumed.

ASSESSMENT OF CAPABILITIES: Calculates the temporal and spatial evolution of a short pulse due to nonlinear amplification and diffraction from circular apertures and lenses; includes laser kinetics appropriate for modeling of CO_2 and Nd: glass laser systems.

ASSESSMENT OF LIMITATIONS: Cylindrical geometry assumed; is not designed for oscillator calculations.

OTHER UNIQUE FEATURES: Models unstable and hole-coupled stable confocal resonators.

ORIGINATOR/KEY CONTACT:

Name: John C. Coldstein and D.O. Dickman Phone: (505) 667-7281

Organization: Los Alamos Scientific Laboratory, Group X-1, MS-531

Address: Los Alamos, New Mexico 87545

AVAILABLE DOCUMENTATION: (T Theory, U User, RP Relevant Publication): (T) (U) LAPU-2: A Laser Pulse Propagation Code With Diffraction, Los Alamos report LA-6955.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Los Alamos Scientific Laboratory

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600/LTSS

TRANSPORTABLE?: No

Machine Dependent Restrictions: Uses storage scheme of 7600 and relies on some aspects of LTSS operating system.

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job	58K (decimal)	10 minutes
Large Job		

Approximate Number of FORTRAN Lines: 2000

CODE NAME: LAPU-2

OPTICS

BASIC TYPE (√)

Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian cylindrical etc.)

Compact Region ____ Annular Region cy

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region	✓	

FIELD SYMMETRY RESTRICTIONS? cylindrical

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ✓ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry ____

Fixed Multiple Resonator Geometries ____

Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Numerical scheme devised by B. R. Suydam, LASL.

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ____

Other ____

RESONATOR TYPE (√) Standing Wave ____

Traveling Wave (Ring) ✓ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ✓ Spherical Mirrors ✓

Cylindrical Mirrors ✓ Telescopes ✓

Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ✓ Gratings ____

Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ✓

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ✓

Overlapped Beams ____

Other ____

FAR-FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ✓

Other ____

KINETICS

GAIN REGION MODELED (√) None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian cylindrical etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ CW ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{\begin{matrix} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{matrix}\right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ____

Hot $(H + F_2)$ ____ Chain $(F + H_2$ & $H + F_2)$ ____

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V-T ____

V-R ____

V-V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None

Cylindrical Radially Flowing ____

Rectangular Linearly Flowing ____

Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar ____ Turbulent ____

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ____

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F ATOM DISSOCIATION FROM (√)

F_2 ____ SF_6 ____

Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME: LOADPL

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: (3-D Loaded Cavity Code with Analytical Gain) The purpose is to model some of the 3-D phenomenology associated with half symmetric unstable resonator with internal axicon (HSURIA) with a radially flowing gain medium; performance predictions for power extraction and beam quality; set/verify design requirements.

ASSESSMENT OF CAPABILITIES: Capable of evaluating any general HSURIA w/reflaxicon. Analytical gain model. General field modifier, mirror misalignment, misfigure, thermal distortion, struts.

ASSESSMENT OF LIMITATIONS: Half plane symmetry, restricted to HSURIA axisymmetric or 3-dimensional calculations.

OTHER UNIQUE FEATURES: General field modifier with deformable mirrors to correct for any aberration.

ORIGINATOR/KEY CONTACT

Name: Alexander M. Simonoff Phone: (213) 884-3346

Organization: Rocketdyne, Laser Optics

Address: 6633 Canoga Ave., Canoga Park, California

AVAILABLE DOCUMENTATION: (T - Theory, U - User, RP - Relevant Publication): (T) (U) Simplified 3-D loaded cavity resonator code-November 1978, G-0-78-1123; see also bare cavity code.

STATUS

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: AFWL

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: Yes (with modification)

Machine Dependent Restrictions: Uses CDC extended core.

SELF-CONTAINED?: No, resonator geometry systems code (for other than PP reflaxicon) 3-D fairfield code.

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job	< 250K	300-600
Typical Job	< 250K	1500 Octal sec
Large Job	< 250K	5000 CDC 176

Approximate Number of FORTRAN Lines:

CODE NAME: LOADPL

OPTICS

BASIC TYPE (✓)
Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (✓):
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region cy Annular Region cy

TRANSVERSE GRID DIMENSIONALITY (✓):

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (✓)
Square ____ Circular ✓ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (✓)
Fixed, Single Resonator Geometry ____
Fixed, Multiple Resonator Geometries ✓
Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)	✓	

Other (specify) ____

CONVERGENCE TECHNIQUE (✓):
Power Comparison ✓ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED?: Yes
Technique Gain convergence algorithm.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓):
Prony ____
Other ____

RESONATOR TYPE (✓): Standing Wave ✓
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (✓): Positive ✓ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (✓):
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	✓	✓
Linear		
Parabola-Parabola	✓	✓
Variable Cone Offset:		✓
Other (specify): P-P tank		✓

Deformable Mirrors: ✓
Spatial Filters: ____ Gratings ____
Other Elements: Corner cube (by using general field modifier to model).

GAIN MODELS (✓): Bare Cavity Only ____
Simple Saturated Gain ✓ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (✓):
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify): Irradiance mapping, bowing, HEX heating.
Reflectivity Loss ✓
Output Coupler Edges: Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (✓)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other Apertures

FAR-FIELD MODELS (✓): Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ____

KINETICS

GAIN REGION MODELED (✓) None
Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (✓):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ **CW:** ____ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (✓):
$\left\{ X + Y_2 \quad YX + Y \right\}$
$\left\{ Y + X_2 \quad YX + X \right\}$

~~X~~	F	Cl	Br	I
H				
D				

Cold (F + H_2): ____
Hot (H + F_2): ____ Chain (F + H_2 & H + F_2) ____
Other (specify): ____

ENERGY TRANSFER MODES MODELED (✓): Reference
V-T ____
V-R ____
V-V ____
Other ____

Single Line Model (✓) ____
Multiline Model (✓) ____

Assumed Rotational Population Distribution State (✓):
Equilibrium ____ Nonequilibrium ____
Number of Laser Lines Modeled ____
Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (✓):
Doppler Broadening ____
Collisional Broadening ____
Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(✓)** None
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (✓): 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (✓)
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (✓)
Premixed ____ Mixing ____
Other (specify) ____
References for Approach Used ____

THERMAL DRIVER MODELED (✓)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (✓)
F_2 ____ SF_6 ____
Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (✓)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)
Media Index Variations ____
Other (specify) ____

CODE NAME: LS-14RGS*

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Performs an exact ray trace analysis in order to determine the geometric configuration of a HSURIA type laser optical resonator with a ray distributing reflaxicon beam compactor assembly. Provides geometry data to wave optics HSURIA codes.

ASSESSMENT OF CAPABILITIES: Capable of synthesizing HSURIA resonators with: (1) parabolic-parabolic; (2) Uniform-Gaussian; (3) Uniform-Lorenzian; (4) P-P TANH redistributing reflaxicon beam compactors. Computes OPDs introduced by the beam compactor. Determines optimum feedback mirror configuration.

ASSESSMENT OF LIMITATIONS: Restricted to HSURIA with nonpowered rear element and to reflaxicon beam compactors.

OTHER UNIQUE FEATURES: Resonator Geometries Modeled: HSURIA, reflaxicon beam compactors. Determines aberration due to beam compactor and transfers data to wave optics codes.

ORIGINATOR/KEY CONTACT:

Name: Victor L. Gamiz **Phone:** (213) 884-3346

Organization: Rocketdyne, Laser Optics

Address: 6633 Canoga Ave., Canoga Park, California (91304)

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) Resonator Geometry Synthesis Code Requirements (V. L. Gamiz); Incorporate General Resonator into Ray Trace Code (W. H. Southwell); Surface Optimization Algorithms and Equations (W. H. Southwell); Equations for Wave Optics Code Parameters (V. L. Gamiz); (U) Resonator Geometry Synthesis Code Development (L. R. Stidham).

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: AFWL

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176, 6600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	70K	20
Typical Job		
Large Job		

Approximate Number of FORTRAN Lines: 1500

*LS-14 Resonator Geometry Synthesizer

CODE NAME: LS-14RGS

OPTICS

BASIC TYPE (√)

Physical Optics ____ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? Meridional

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ✓ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry ✓

Fixed Multiple Resonator Geometries ____

Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Ray trace

CONVERGENCE TECHNIQUE (√) N/A

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony N/A

Other ____

RESONATOR TYPE (√) Standing Wave N/A

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ✓ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ✓ Spherical Mirrors ✓

Cylindrical Mirrors ____ Telescopes ✓

Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		✓
Variable Cone Offset		✓
Other (specify) PPTANH		✓

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√) Bare Cavity Only N/A

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√) N/A

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√) N/A

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (√) Beam Steering Removal N/A

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (√) None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ CW ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ____

Hot $(H + F_2)$ ____ Chain $(F + H_2$ & $H + F_2)$ ____

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V T ____

V R ____

V V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None

Cylindrical Radially Flowing ____

Rectangular Linearly Flowing ____

Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar ____ Turbulent ____

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ____

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F ATOM DISSOCIATION FROM (√)

F_2 ____ SF_6 ____

Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME MCLANC

CODE TYPE Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Modeling of a real gas flow by tracking several thousand simulated molecules. Primarily used for modeling nozzle flows with large base regions, and low pressure regions in hypersonic wedge wakes.

ASSESSMENT OF CAPABILITIES Use of this method on a wide variety of problems has shown no sign of instability in operation.

ASSESSMENT OF LIMITATIONS Large array sizes for flowfield cell network and molecular information imposes limits on size of flowfield which can be analyzed in one run. Cavity radiation interaction not included.

OTHER UNIQUE FEATURES Developed cavity initial conditions for a large number of cavity injector systems. Includes nonequilibrium chemical reactions, models shock waves, recirculating flows, and transverse pressure gradient.

ORIGINATOR/KEY CONTACT

Name: R. Hughes and H. W. Behrens Phone: (213) 536-1624

Organization: TRW DSSG

Address: RI/1038, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION (T = Theory, U = User, RP = Relevant Publication): (RP): "Chemical Laser Nozzle and Cavity Calculations by the Direct Simulation Monte Carlo Method," T. Sugimura, G. A. Bird, and H. W. Behrens, presented at AIAA Conference on High Power Lasers, Oct. 31-Nov. 2, 1978, Cambridge, Massachusetts.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: TRW

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	250K	400
Typical Job	500K	2000
Large Job	1000K	4000

Approximate Number of FORTRAN Lines: 5000

CODE NAME: MCLANC

OPTICS

BASIC TYPE (√) None
Physical Optics ___ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ___ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ___

MIRROR SHAPE(S) ALLOWED (√)
Square ___ Circular ___ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ___
Fixed Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	M.A.	ANN. A.
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√)
Power Comparison ___ Field Comparison ___
Other ___

ACCELERATION ALGORITHMS USED? ___
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

None

RESONATOR TYPE (√) Standing Wave ___
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√) Positive ___ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ___ Spherical Mirrors ___
Cylindrical Mirrors ___ Telescopes ___
Scraper Mirrors ___

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√) Bare Cavity Only ___
Simple Saturated Gain ___ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ___ Decentration ___
Aberrations/Thermal Distortions
Arbitrary ___
Selected (specify) ___
Reflectivity Loss ___
Output Coupler Edges Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ___
Optimal Focal Search ___ Beam Quality ___
Other ___

KINETICS

GAIN REGION MODELED (√) None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED ___ CW ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)
$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V T ___
V R ___
V V ___
Other ___

Single Line Model (√) ___
Multiline Model (√) ___

Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___

Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical Radially Flowing √
Rectangular Linearly Flowing √
Other ___

COORDINATE SYSTEM Cartesian

FLUID GRID DIMENSION (√) 1D ___ 2D √ 3D ___

FLOW FIELD MODELED (√)
Laminar ___ Turbulent ___
Other Noncontinuum; direct simul.

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ___
Other (specify) Kinetic theory, which does the mixing on the molecular scale.
References for Approach Used "Molecular Gas Dyn." G. A. Bird, Oxford, 1976.

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F ATOM DISSOCIATION FROM (√)
F_2 √ SF_6 ___
Other (specify) ___

F ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers √ Shock Waves √
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) Base region recirculation.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations √
Other (specify) ___

CODE NAME MNORO

CODE TYPE: Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Predict power and power spectral distribution of CW chemical lasers. Also see AFOPTMNORO.

ASSESSMENT OF CAPABILITIES: Can predict power and power spectral distribution on 2→1 band for CW chemical lasers, typical case takes 100-200 seconds on Cyber 175. Contains Fabry-Perot resonator. With the rotational nonequilibrium kinetics, code will predict which lines lase.

ASSESSMENT OF LIMITATIONS: Need to include rotational nonequilibrium on 1→0 band.

OTHER UNIQUE FEATURES: The following quantities are input as polynomials: T(x), P(x), U(x), $\dot{m}_p(x)$ (flow rate remaining in primary), $\dot{m}_s(x)$ (flow rate remaining in secondary), primary nozzle F atom boundary layer profile, and Le/Lg(x) (thickness of mixed flow). Coefficients of the polynomials are obtained by fits to these profiles (profiles come from BLAZE II, LAMP, etc.)

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman   Phone: (217) 333-1834

Organization: Aeronautical and Astronautical Engineering Dept., University of Illinois

Address: Urbana, Illinois 61801

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) "An Efficient Rotational Nonequilibrium Model of CW Chemical Lasers," L. H. Sentman and W. Brandkamp, AAE TR 79-5, UILU Eng 79-0505 (July 1979); (U) "Users Guide for Programs MNORO and AFOPTMNORO," L. H. Sentman, AAE TR 79-7, UILU Eng 79-0507 (October 1979).

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: AFOSR

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 175

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job	All jobs same size	50-100 sec
Large Job:		

Approximate Number of FORTRAN Lines:

CODE NAME: MNORO

OPTICS

BASIC TYPE (√)
Physical Optics ____ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√):
Square ____ Circular ____ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ____
Fixed, Multiple Resonator Geometries ____
Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)
Power Comparison ____ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? ____
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ____
Other ____

RESONATOR TYPE (√): Standing Wave ____
Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√): Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (√): Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity Loss ____
Output Coupler Edges: Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR-FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (√):
Compact Region ✓ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ **CW:** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
{X + Y₂ → YX + Y}
{Y + X₂ → YX + X}

X	F	Cl	Br	I
H	✓			
D	✓			

Cold (F + H_2): ✓
Hot (H + F_2): ✓ Chain (F + H_2 & H + F_2): ✓
Other (specify) ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T ✓
V-R ✓
V-V ____
Other: Multiquantum V-T, F-atom wall recombination.

Single Line Model (√) ____
Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium ✓

Number of Laser Lines Modeled ~~lines~~ Predicts which lase.

Source of Rate Coefficients Used in Code: Cohen's HF/DF rate package, Hinchen's rotational*

LINE PROFILE MODELS (√):
Doppler Broadening ____
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)**
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ✓
Other ____

COORDINATE SYSTEM: Cartesian

FLUID GRID DIMENSION (√): 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√):
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (√):
Premixed ____ Mixing ____
Other (specify) ✓

References for Approach Used ____

THERMAL DRIVER MODELED (√):
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (√)
F_2 ____ SF_6 ____
Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

Relaxation data, Polanyi's pumping distribution.

CODE NAME: MPCPAGOS

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: (Derivative of IPAGOS and POLYPAGOS); calculates sensitivity coefficients for general optical train; relates output ray motions to individual optical element motions in six degrees of freedom; used in conjunction with NASTRAN to predict beam jitter through an integrated optics/structures approach.

ASSESSMENT OF CAPABILITIES: Can handle all elements of IPAGOS, but also includes an unstable resonator modeling capability.

ASSESSMENT OF LIMITATIONS: Meant to be used to generate multipoint constraint (MPC) cards for NASTRAN; output format is rough and difficult for novice to interpret.

OTHER UNIQUE FEATURES: Resonator Geometries Modeled: Unstable, Linear, with up to 4 folding flats.

ORIGINATOR/KEY CONTACT:

Name: D. Mansell/C. Barnard Phone: (505) 848-5000

Organization: The BDM Corporation

Address: 1801 Randolph Road, S.E., Albuquerque, New Mexico 87106

AVAILABLE DOCUMENTATION: (T Theory, U User, RP Relevant Publication): (T) "Final Task Report for Sensitivity Analyses of the All Optical Train," BDM/TAC-78-793-TR; (U) "MPCPAGOS Users Manual," BDM/TAC-78-727-TR.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: AFWL/LRO, BDM

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600/7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose): NASTRAN uses MCPAGOS output

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	120K	1 sec
Large Job:		

Approximate Number of FORTRAN Lines: 6K

CODE NAME: MPCPAGOS

OPTICS

BASIC TYPE (√)

Physical Optics ____ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ✓ Annular Region ✓

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? No

MIRROR SHAPE(S) ALLOWED (√)

Square ✓ Circular ✓ Strip ✓

Rectangular ✓ Elliptical ✓ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed: Single Resonator Geometry ✓ (Branch, Unstable)

Fixed: Multiple Resonator Geometries ____

Modular: Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE (√)

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ____

Other ____

RESONATOR TYPE (√) Standing Wave ✓

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ✓ Spherical Mirrors ✓

Cylindrical Mirrors ✓ Telescopes ✓

Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	✓	✓
Linear	✓	✓
Parabola-Parabola	✓	✓
Variable Cone Offset	✓	✓
Other (specify) Noneverting	✓	

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt ✓ Decentration ✓

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges: Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR-FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other 2-dimensional Fourier transform

KINETICS

GAIN REGION MODELED (√) None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ CW ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\{X + Y_2 \quad YX + Y\}$

$\{Y + X_2 \quad YX + X\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ____

Hot $(H + F_2)$ ____ Chain $(F + H_2$ & $H + F_2)$ ____

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V-T ____

V-R ____

V-V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None

Cylindrical: Radially Flowing ____

Rectangular: Linearly Flowing ____

Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar ____ Turbulent ____

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ____

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F ATOM DISSOCIATION FROM (√)

F_2 ____ SF_6 ____

Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME MRO

CODE TYPE Optics, Kinetics, and Gasdynamics.

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Models the optical performance of linear bank CW HF and DF chemical lasers. MRO is 2D model; BLAZER is 3D model. Used as design tools for BDL, NACL, MIRACL.

ASSESSMENT OF CAPABILITIES Resonator: Positive or negative branch confocal unstable; arbitrary optical axis position; cylindrical, toric, or spherical mirrors. Gain medium: CW flowing HF* or DF*, strut wake, mirror aberration, thermal distortion, and nonresonant index OPD's

MRO does stable Fabry Perot with geometrical optics.

ASSESSMENT OF LIMITATIONS Lacks transverse pressure gradient modeling capability, lacks FFT propagation algorithm, uses only single gain sheet, uses only rotational equilibrium description.

OTHER UNIQUE FEATURES Confocal unstable resonator modeled.

ORIGINATOR/KEY CONTACT

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: RI/1162, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION (T - Theory, U - User, RP - Relevant Publication) (T): The BLAZER and MRO Codes, June 1978; (U): BLAZER User Manual, November 1978 (includes MRO); Listings available.

STATUS

Operational Currently? Yes

Under Modification? Planned

Purpose(s) Rotational nonequilibrium, FFT propagation algorithm, multiple gain skins, transverse pressure gradient description.

Ownership? Government

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed) Cyber 174-TRW/TSS

TRANSPORTABLE? Needs mods for export

Machine Dependent Restrictions CDC

SELF-CONTAINED?

Other Codes Required (name, purpose) VIINT, KBLIMP, ALFA for nozzle exit condition.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)		Execution Time (Sec, CDC 7600)	
Small Job	MRO: ----	BLAZER: -	---	---
Typical Job	151K	165K	400	6500
Large Job	---	245K	---	15000

Approximate Number of FORTRAN Lines MRO: 4500 BLAZER: 6000

CODE NAME: MRO

OPTICS

BASIC TYPE (√)
Physical Optics √ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar √ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region	√	
Annular Region		

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ____ Strip √
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ____
Fixed Multiple Resonator Geometries √
Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature (Modified)	√	
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)
Power Comparison √ Field Comparison ____
Other ____

ACCELERATION ALGORITHMS USED? No
Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave √
Traveling Wave (Ring) √ Reverse TW ____

BRANCH (√): Positive √ Negative √

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors √ Telescopes ____
Scraper Mirrors √

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirror ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain √

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt √ Decentration ____
Aberrations/Thermal Distortions
Arbitrary √
Selected (specify) ____
Reflectivity Loss √
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation √
Gas Absorption ____
Overlapped Beams ____
Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality √
Other EMBLAZON

KINETICS

GAIN REGION MODELED (√)
Compact Region √ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region	√	√	
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? √ Flow Direction? √

PULSED ____ **CW** √ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√)
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$
Cold $(F + H_2)$ √
Hot $(H + F_2)$ ____ Chain $(F + H_2 \,\&\, H + F_2)$ ____
Other (specify) ____

	F	Cl	Br	I
H	√			
D	√			

ENERGY TRANSFER MODES MODELED (√) Reference
VT √ The BLAZER and MRO Codes
VR ____
VV √ The BLAZER and MRO Codes
Other RR with rot. nonequil.

Single Line Model (√) ____
Multiline Model (√) √

Assumed Rotational Population Distribution State (√)
Equilibrium √ Nonequilibrium ____

Number of Laser Lines Modeled 24
Source of Rate Coefficients Used in Code N. Cohen

LINE PROFILE MODELS (√)
Doppler Broadening √
Collisional Broadening √
Other (specify) Operation at line center.

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√)**
Cylindrical Radially Flowing ____
Rectangular Linearly Flowing √
Other ____

COORDINATE SYSTEM Cartesian

FLUID GRID DIMENSION (√) 1D √ 2D ____ 3D ____

FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other Scheduled mixing.

BASIC MODELING APPROACH (√)
Premixed ____ Mixing ____
Other (specify) Scheduled mixing.

References for Approach Used The BLAZER and MRO Codes (TRW).

THERMAL DRIVER MODELED (√)
Arc Heater ____ Combustor √
Shock Tube ____ Resistance Heater ____
Other ____

F ATOM DISSOCIATION FROM (√)
F_2 √ SF_6 ____
Other (specify) NF_3

F ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED He, N_2, CF_4

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) Scheduled three stream: fuel, oxidant, mixed.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations √
Other (specify) ____

CODE NAME NCFTDPWE*

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Study of wavefront distortions during propagation through amplifying self-focusing media.

ASSESSMENT OF CAPABILITIES: This code propagates a two (transverse) dimensional wavefront through a medium with constant small signal gain and with a nonlinear index cf refraction which induces self-focusing. The code was written by F.D. Tappert, now at the University of Miami in Miami, Florida. A description is in Los Alamos report LA-6833-MS by John C. Goldstein.

ASSESSMENT OF LIMITATIONS: Although this code could be extended to be used in resonator calculations, it currently does not have any optical elements or saturable gain models included. Therefore, other than noting that the fast Fourier transform is the basic numerical method employed and that other details can be found in the report cited, no other data for this code will be given.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: F.D. Tappert/John C. Goldstein Phone: (505) 667-7281

Organization: Los Alamos Scientific Laboratory, Group X-1, MS-531

Address: Los Alamos, New Mexico 87545

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication): (T) A Numerical Code for the Three Dimensional Parabolic Wave Equation, John C. Goldstein, Los Alamos report number LA-6833-MS.

STATUS:

Operational Currently?

Under Modification?

Purpose(s):

Ownership?

Proprietary?

MACHINE/OPERATING SYSTEM (on which installed):

TRANSPORTABLE?

Machine Dependent Restrictions:

SELF-CONTAINED?

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job		
Large Job		

Approximate Number of FORTRAN Lines:

*Numerical Code for the Three Dimensional Parabolic Wave Equation

CODE NAME: NCFTDPWE

OPTICS

None

BASIC TYPE (√) None

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ____ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed, Single Resonator Geometry ____

Fixed, Multiple Resonator Geometries ____

Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ____

Other ____

RESONATOR TYPE (√) Standing Wave ____

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√):

Flat Mirrors ____ Spherical Mirrors ____

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (√): Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (√) None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ____

Hot $(H + F_2)$ ____ Chain $(F + H_2 \,\&\, H + F_2)$ ____

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V-T ____

V-R ____

V-V ____

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None

Cylindrical, Radially Flowing ____

Rectangular, Linearly Flowing ____

Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√): 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar ____ Turbulent ____

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ____

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F-ATOM DISSOCIATION FROM (√)

F_2 ____ SF_6 ____

Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME NORO-I

CODE TYPE: Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models rotational nonequilibrium effects in CW chemical lasers. (Combined with other optics models, e.g., see ROPTICS).

ASSESSMENT OF CAPABILITIES: Predicts power spectral distribution, effect of rotational nonequilibrium on laser performance.

ASSESSMENT OF LIMITATIONS: Qualitative model, 2 vibrational levels, 21 P-branch and 21 R-branch lines, Fabry-Perot cavity, fluid dynamic variables p, ρ, T, u input as constants, premixed.

OTHER UNIQUE FEATURES: This model was used to demonstrate the importance of rotational nonequilibrium effects in CW chemical lasers. To ascertain the role of the resonator, it was coupled to the Bell Aerospace strip resonator code and run with a confocal unstable resonator. In this form the code is known as ROPTICS.

ORIGINATOR/KEY CONTACT:

Name: L. H. Sentman Phone: (217) 333-1834

Organization: Aeronautical and Astronautical Engineering Dept., University of Illinois

Address: Urbana, Illinois 61801

AVAILABLE DOCUMENTATION (T - Theory, U - User, RP - Relevant Publication): (T) J. Chemical Physics 62, 3523 (1975); (RP) Applied Optics 15, 744 (1976); (RP) J. Chemical Physics 67, 966 (1977); (RP) Applied Optics 17, 2244 (1978).

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Bell Aerospace TEXTRON

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): IBM, CDC

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job	All jobs same size	15 sec
Large Job		

Approximate Number of FORTRAN Lines

CODE NAME: NORO-I

OPTICS

BASIC TYPE (√) None
Physical Optics ____ Geometrical √
FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ____ Vector ____
COORDINATE SYSTEM (Cartesian cylindrical etc.)
Compact Region ____ Annular Region ____
TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____
MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ____ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____
CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ____
Fixed Multiple Resonator Geometries ____
Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE		
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (√)
Power Comparison ____ Field Comparison ____
Other ____
ACCELERATION ALGORITHMS USED? ____
Technique ____
MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave ____
Traveling Wave (Ring) ____ Reverse TW ____
BRANCH (√) Positive ____ Negative ____
OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ____ Spherical Mirrors ____
Cylindrical Mirrors ____ Telescopes ____
Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____
Simple Saturated Gain ____ Detailed Gain ____
BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ____ Decentration ____
Aberrations/Thermal Distortions
Arbitrary ____
Selected (specify) ____
Reflectivity L ____
Output Coupler Edges Rolled ____
Serrated ____ Other ____
LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ____
Gas Absorption ____
Overlapped Beams ____
Other ____
FAR FIELD MODELS (√) Beam Steering Removal ____
Optimal Focal Search ____ Beam Quality ____
Other ____

KINETICS

GAIN REGION MODELED (√)
Compact Region √ Annular Region ____
COORDINATE SYSTEM (Cartesian cylindrical etc.)
Compact Region cd Annular Region ____
KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region	√		
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ____ Flow Direction? ____
PULSED ____ CW √ KINETICS MODELED
CHEMICAL PUMPING REACTIONS MODELED (√)
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$

Y^X	F	Cl	Br	I
H	√			
D				

Cold ($F + H_2$) √
Hot ($H + F_2$) ____ Chain ($F + H_2$ & $H + F_2$) ____
Other (specify) ____
ENERGY TRANSFER MODES MODELED (√) Reference
V T √
V R √
V V
Other ____
Single Line Model (√) ____
Multiline Model (√) √
Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium √
Number of Laser Lines Modeled Predicts which lines lase.
Source of Rate Coefficients Used in Code Cohen's HF rate package, Hinchen's rotational*
LINE PROFILE MODELS (√)
Doppler Broadening √
Collisional Broadening ____
Other (specify) Voight profile.

*relaxation data, Polanyi's pumping distribution.

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical Radially Flowing ____
Rectangular Linearly Flowing √
Other ____
COORDINATE SYSTEM Cartesian
FLUID GRID DIMENSION (√) 1D √ 2D ____ 3D ____
FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other ____
BASIC MODELING APPROACH (√)
Premixed √ Mixing ____
Other (specify) ____
References for Approach Used ____
THERMAL DRIVER MODELED (√)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____
F ATOM DISSOCIATION FROM (√)
F_2 ____ SF_6 ____
Other (specify) ____
F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____
DILUENTS MODELED √
MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____
MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

CODE NAME: OCELOT

CODE TYPE Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Tool to assist with resonator design and mode control.

ASSESSMENT OF CAPABILITIES Very flexible code that can model almost any resonator we have been interested in - annular or compact. Both Cartesian and cylindrical coordinate systems are used, but there are more elements available in Cartesian coordinates at present. Simultaneous multiple spectral lines with coupled transitions used in simple gain model.

ASSESSMENT OF LIMITATIONS Limited almost exclusively by lack of models for those elements we have not had time to write models for.

OTHER UNIQUE FEATURES Modeled HSURIA, unstable P-P axicon negative branch ring; many compact, folded resonator/amplifiers, both confocal and nonconfocal. Allows amplifier beams to overlap resonator medium. User can specify any number of field stations located wherever desired. Utilizes both Cartesian and cylindrical coordinate systems.

ORIGINATOR/KEY CONTACT:

Name: David Fink 6/C 129 Phone: (213) 391-0711, Ext. 6925

Organization: Hughes Aircraft Company

Address: Culver City, California 90230

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): Not available.

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): Increase number of models in cylindrical coordinates.

Ownership?: Hughes Aircraft Company

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600 CDC 176

TRANSPORTABLE?: Almost, previous versions have been converted to IBM.

Machine Dependent Restrictions: Control Data large core and external file usage.

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job	100K	50
Typical Job	140K	500
Large Job	200K	5,000

Approximate Number of FORTRAN Lines

CODE NAME: OCELOT

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ___ Vector ✓ with multiple spectral lines.

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region ✓ Annular Region cy

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region Ca, cy		✓
Annular Region cy		✓

FIELD SYMMETRY RESTRICTIONS? left-right*

MIRROR SHAPE(S) ALLOWED (√) for Cartesian:
Square ✓ Circular ✓+ Strip ___
Rectangular ✓ Elliptical ✓ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging	✓	✓
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)	✓	

Other (specify) ___

CONVERGENCE TECHNIQUE (√):
Power Comparison ✓ Field Comparison ✓ (visual)
Other ___

ACCELERATION ALGORITHMS USED? No
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ✓

BRANCH (√): Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ✓ Telescopes ___
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		✓
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ✓
Simple Saturated Gain ✓ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√) Cartesian*
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ___
Selected (specify) Hughes mirror model.
Reflectivity Loss ✓
Output Coupler Edges Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ✓
Gas Absorption ✓
Overlapped Beams ✓
Other Any number & loca. of gain sheets.

FAR-FIELD MODELS (√): Beam Steering Removal ✓*
Optimal Focal Search ✓* Beam Quality ✓*
Other ___

KINETICS

GAIN REGION MODELED (√): None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ CW: ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$

X/Y	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2 \& H + F_2)$ ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ___
V-R ___
V-V ___
Other ___
Single Line Model (√) ___
Multiline Model (√) ___
Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___

FLUID GRID DIMENSION (√) 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√)
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

+also for cylindrical coordinates. *cylindrical in progress.
*(restriction will be removed.)

CODE NAME: POLRES/POLRESH

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Axisymmetric, Half-symmetric Unstable Resonator Analysis with two Fourier components for analysis of polarization effect. POLRESH-HSURIA modification.

ASSESSMENT OF CAPABILITIES: Bare resonator analysis for polarization effects.

ASSESSMENT OF LIMITATIONS: No-gain effects, resonator specific HSUR and HSURIA.

OTHER UNIQUE FEATURES: Models HSUR, HSURIA--linear-linear, PP wax or reflax. Analysis of polarization effects.

ORIGINATOR/KEY CONTACT:

Name: William P. Latham   Phone: (505) 844-0721

Organization: AFWL/ALR

Address: Kirtland Air Force Base, New Mexico 87117

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (RP) G. C. Dente, Applied Optics 18, 2911 (1979); W. P. Latham, "Polarization Effects in a Half-Symmetric Unstable Resonator with a Coated Rear Cone," Applied Optics, to be published.

STATUS:

Operational Currently?: Yes

Under Modification?: H version for HSURIA, simple saturable gain, ring analysis of Chodzke and

Purpose(s): Huguley's experiments.

Ownership?: Government-AFWL

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 176 (AFWL)

TRANSPORTABLE?: No

Machine Dependent Restrictions: Machine language FFT.

SELF-CONTAINED?:

Other Codes Required (name, purpose): IMSLLIB-LEQ2C - linear equation solution
ASPLIB-ZRPCC - polynomial root solution

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:	175K	60
Large Job:		

Approximate Number of FORTRAN Lines:

CODE NAME: POLRES/POLRESH

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ___ Vector ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region Both	✓	
Annular Region *	✓	

FIELD SYMMETRY RESTRICTIONS? ___

MIRROR SHAPE(S) ALLOWED (√)
Square ___ Circular ✓ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ✓
Fixed Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging *		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT) *		✓
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)	✓	

Other (specify) ___

CONVERGENCE TECHNIQUE (√)
Power Comparison ✓ Field Comparison ___
Other Krylov Matrix Method

ACCELERATION ALGORITHMS USED?
Technique Krylov

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ___
Other Krylov

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√) Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ___ Telescopes ___
Scraper Mirrors ___

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear *	✓	✓
Parabola-Parabola *	✓	✓
Variable Cone Offset		
Other (specify):		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only None
Simple Saturated Gain ___ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√) None
Mirror Tilt ___ Decentration ___
Aberrations/Thermal Distortions
Arbitrary ___
Selected (specify) ___
Reflectivity Loss ___
Output Coupler Edges Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√) None
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR FIELD MODELS (√) Beam Steering Removal None
Optimal Focal Search ___ Beam Quality ___
Other ___

KINETICS

GAIN REGION MODELED (√) None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED ___ CW ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)
$X + Y_2$ $YX + Y$
$Y + X_2$ $YX + X$

Y\X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2 \& H + F_2)$ ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ___
V-R ___
V-V ___
Other ___

Single Line Model (√) ___
Multiline Model (√) ___
Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical Radially Flowing ___
Rectangular Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___

FLUID GRID DIMENSION (√) 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√)
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

* H version only

CODE NAME: POP

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: POP (Physical Optics Propagation) Code; Physical optics analysis of general HEL optical system and atmospheric propagation. Not limited to HEL resonators. Can model CW or pulsed CO_2 EDL, GDL and iodine lasers.

ASSESSMENT OF CAPABILITIES: General purpose, versatile code which is easily applied to HEL problems including resonators, beam transfer optics, atmospherics, and adaptive optics.

ASSESSMENT OF LIMITATIONS: Normal limits due to sampling and aliasing requirements. Transverse grid dimensionality: (1) Compact Region: (a) 2-D Cartesian, $2^N \times 2^M$, N+M = 16; (b) 2-D cylindrical 2048 radial points x 1 azimuthal modes (1 · 300); (2) Annular region: 1-D cylindrical, 2048 radial points x 1 azimuthal modes (1 · 300).

OTHER UNIQUE FEATURES: Principle Resonator Geometries Modeled: HSURIA, Compact Unstable Confocal or Non-Confocal, Compact Unstable Astigmatic (or Toric, Toric Unstable Resonators (Annular), Oscillator/Amplifier. A versatile interface routine allows use of a variety of kinetic models with the POP. Other features include ZERNIKE polynomial decomposition and modification, pulsed or CW thermal blooming, kinetic cooling.

ORIGINATOR/KEY CONTACT:

Name: Dr. Peter B. Mumola Phone: (203) 762-4415

Organization: Perkin-Elmer Corporation

Address: 50 Danbury Rd./Ms 241, Wilton, Connecticut 06897

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) Available; (U) Available

STATUS

Operational Currently? Yes

Under Modification? As required

Purpose(s):

Ownership? Perkin-Elmer

Proprietary? Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600, CYBER 176, IBM 3032, CRAY, CRAY-1 (In progress).

TRANSPORTABLE? Yes

Machine Dependent Restrictions:

SELF-CONTAINED? No

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job	200K (SCM), 240K (LCM)	56 sec. (CYBER 176) 1 iteration (loaded cavity
Large Job		Pulsed EDL (CO_2)

Approximate Number of FORTRAN Lines: ≈10,000

CODE NAME: POP

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Both Annular Region Strip

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region cy Ca		✓
Annular Region	✓	

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√)
Square ✓ Circular ✓ Strip ✓
Rectangular ✓ Elliptical ✓ Arbitrary ✓*

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ___
Modular, Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)	✓	

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison ✓ Field Comparison ✓
Other Phase, RMS Intensity, Coupling.

ACCELERATION ALGORITHMS USED? ✓
Technique Field/Gain averaging, Dynamic averaging.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√): Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ___

BRANCH (√) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ✓ Telescopes ✓
Scraper Mirrors ✓
Axicons
Arbitrary
Linear
Parabola-Parabola
Variable Cone Offset
Other (specify)
in progress

Waxicons	Reflaxicons

Deformable Mirrors ✓
Spatial Filters ✓ Gratings ✓
Other Elements Generalized conics, windows, struts.

GAIN MODELS (√): Bare Cavity Only ✓
Simple Saturated Gain ✓ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions:
Arbitrary ✓
Selected (specify) As per HAC mirror model.
Reflectivity Loss ✓
Output Coupler Edges: Rolled ✓
Serrated ✓ Other Different rad. of curv.

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ✓
Gas Absorption ✓
Overlapped Beams ✓
Other ___

FAR-FIELD MODELS (√): Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other Adaptive optics evaluation, Atmospheric propagation effects

KINETICS

GAIN REGION MODELED (√): None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ CW: ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$

	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$: ___
Hot $(H + F_2)$: ___ Chain $(F + H_2 \& H + F_2)$: ___
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ___
V-R: ___
V-V: ___
Other: ___
Single Line Model (√): ___
Multiline Model (√): ___
Assumed Rotational Population Distribution State (√):
Equilibrium: ___ Nonequilibrium: ___
Number of Laser Lines Modeled: ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM: ___

FLUID GRID DIMENSION (√): 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√):
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√):
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√):
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2 ___ SF_6 ___
Other (specify): ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify): ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

*Generalized conics

CODE NAME: PRE-WATSON

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Evaluate impact on resonator solution of conical element polarization.

ASSESSMENT OF CAPABILITIES: Models polarization of conical mirror. Allows arbitrary selection of reflectivity and phase delay.

ASSESSMENT OF LIMITATIONS: Low resolution, only models polarization.

OTHER UNIQUE FEATURES: Resonator Geometries Modeled: half symmetric unstable resonator with rear cone. Rear cone polarization.

ORIGINATOR/KEY CONTACT:

Name: Phillip D. Briggs Phone: (213) 884-3851
Organization: Rockwell International, Rocketdyne Division
Address: 6633 Canoga Ave., Canoga Park, California (91304)

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (RP) Various papers in open literature.

STATUS:

Operational Currently?: Yes
Under Modification?:
Purpose(s):

Ownership?: Developed under contract to AFWL.
Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: Yes, with mod.
Machine Dependent Restrictions: Uses CDC-extended core.

SELF-CONTAINED?: Yes
Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	70K 5 cm, 200K 6 cm	< 1 min
Large Job:		

Approximate Number of FORTRAN Lines: 600

CODE NAME: PRE-WATSON

OPTICS

BASIC TYPE (√)

Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar ____ Vector ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region CY Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		✓
Annular Region		

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (√)

Square ____ Circular ✓ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry ✓

Fixed Multiple Resonator Geometries ____

Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)	✓	

Other (specify) ____

CONVERGENCE TECHNIQUE (√)

Power Comparison ____ Field Comparison ____

Other Eigenvalue

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony ✓

Other ____

RESONATOR TYPE (√) Standing Wave ✓

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (√) Positive ✓ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors ____ Spherical Mirrors ✓

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements Cone

GAIN MODELS (√) Bare Cavity Only ✓

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt ____ Decentration ____

Aberrations/Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (√) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ✓

Other ____

KINETICS

GAIN REGION MODELED (√) None

Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ CW ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ X + Y_2 \quad YX + Y \right\}$

$\left\{ Y + X_2 \quad YX + X \right\}$

Cold ($F + H_2$) ____

Hot ($H + F_2$) ____ Chain ($F + H_2$ & $H + F_2$) ____

Y^X	F	Cl	Br	I
H				
D				

Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference

V-T		
V-R		
V-V		

Other ____

Single Line Model (√) ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)

Doppler Broadening ____

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None

Cylindrical Radially Flowing ____

Rectangular Linearly Flowing ____

Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)

Laminar ____ Turbulent ____

Other ____

BASIC MODELING APPROACH (√)

Premixed ____ Mixing ____

Other (specify) ____

References for Approach Used ____

THERMAL DRIVER MODELED (√)

Arc Heater ____ Combustor ____

Shock Tube ____ Resistance Heater ____

Other ____

F ATOM DISSOCIATION FROM (√)

F_2 ____ SF_6 ____

Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations ____

Other (specify) ____

CODE NAME QFHT

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The QFHT (quasi fast Hankel transform) code was developed as a tool for modeling high Fresnel number annular resonators.

ASSESSMENT OF CAPABILITIES: The QFHT code will model azimuthally symmetric resonators with collimated Fresnel numbers in excess of 200. Code will model large variety of unstable resonators, positive or negative branch, annular or ring. Modular code construction is used with resonator geometry determined by input.

ASSESSMENT OF LIMITATIONS: Because of storage requirements, resonators with severe azimuthal variations (i.e. 16 modes) and large (25) Fresnel numbers cannot be adequately sampled.

OTHER UNIQUE FEATURES: Models positive and negative compact unstable confocal resonators, rings, rings with IFPA (inter focal point aperture), misaligned and offset axicon cones, and extra cavity phase correction.

ORIGINATOR/KEY CONTACT:

Name: Paul E. Fileger **Phone:** (305) 840-6643

Organization: United Technologies Research Center, OATL

Address: P.O. Box 2691, MS-R-48 West Palm Beach, Florida 33402

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): None

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): To incorporate multiline loaded capabilities by coupling to CLOQ3D kinetics package.

Ownership?: UTRC

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC-176, IBM-370

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

CODE NAME: OFHT

OPTICS

BASIC TYPE (✓)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (✓)
Scalar ✓ Vector In process

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (✓)

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (✓)
Square ✓ Circular ___ Strip ✓
Rectangular ✓ Elliptical ✓ Arbitrary ___

CONFIGURATION FLEXIBILITY (✓)
Fixed Single Resonator Geometry ___
Fixed Multiple Resonator Geometries ___
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature	✓	✓
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Radial asympototic propagator.

CONVERGENCE TECHNIQUE (✓)
Power Comparison ___ Field Comparison ✓
Other Will also use power when loaded.

ACCELERATION ALGORITHMS USED? Yes
Technique Field averaging.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓)
Prony ✓
Other ___

RESONATOR TYPE (✓) Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ✓

BRANCH (✓) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (✓)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ✓ Telescopes ✓ (geometric)
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	In progress	
Linear	✓	
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ✓
Spatial Filters ✓ Gratings ___
Other Elements Misaligned and offset cones

GAIN MODELS (✓) Bare Cavity Only ✓
Simple Saturated Gain ___ Detailed Gain (in work)

BARE CAVITY FIELD MODIFIER MODELS (✓)
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ✓
Selected (specify) ___
Reflectivity Loss ✓
Output Coupler Edges Rolled ✓
Serrated ✓ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (✓)
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR FIELD MODELS (✓) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ___

KINETICS

GAIN REGION MODELED (✓) None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (✓)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED ___ CW ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (✓)
$X + Y_2 \quad YX + Y$
$Y + X_2 \quad YX + X$
Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2 \& H + F_2)$ ___
Other (specify) ___

Y^X	F	Cl	Br	I
H				
D				

ENERGY TRANSFER MODES MODELED (✓) Reference
V T ___
V R ___
V V ___
Other ___

Single Line Model (✓) ___
Multiline Model (✓) ___

Assumed Rotational Population Distribution State (✓)
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (✓)
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (✓) None
Cylindrical Radially Flowing ___
Rectangular Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___

FLUID GRID DIMENSION (✓) 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (✓)
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (✓)
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (✓)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F ATOM DISSOCIATION FROM (✓)
F_2 ___ SF_6 ___
Other (specify) ___

F ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (✓)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)
Media Index Variations ___
Other (specify) ___

CODE NAME RASCAL

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Resonator parameter selection, assess mode control, performance predictions for power and beam quality, resonator perturbation analysis, beam quality budgeting, set/verify design requirements.

ASSESSMENT OF CAPABILITIES: 3-D optics calculation with general field modifier models coupled to AEROKNS code for kinetics and gasdynamics calculations. Code uses modular construction (see AEROKNS for more details).

ASSESSMENT OF LIMITATIONS: Kinetics model does not include rotational nonequilibrium. Code is presently being developed.

OTHER UNIQUE FEATURES: Resonator geometries modeled: HSURIA w/waxicon or reflaxicon (general surface), ring w/waxicon or reflaxicon (general surface). Beam rotators, axisymmetric mode competition, 3D basis set competition.

ORIGINATOR/KEY CONTACT:

Name: Phil Briggs Phone: (213) 884-3351

Organization: Rockwell International-Rocketdyne Division

Address: 6633 Canoga Ave., Canoga Park, California 91304

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication): (T) Annular Laser Optics Study Final Report (AFWL-TR-77-117) (U) Annular Laser Optics Study User's Manual: Loaded Cavity Codes.

STATUS:

Operational Currently? No

Under Modification? Under development

Purpose(s)

Ownership? Rockwell International

Proprietary? Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE? With modification.

Machine Dependent Restrictions: Uses CDC extended core.

SELF-CONTAINED?

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec CDC 7600)
Small Job	200K SCM - 200K LCM	?
Typical Job	200K SCM - 500K LCM	?
Large Job	200K SCM -1000K LCM	?

Approximate Number of FORTRAN Lines ?

CODE NAME: RASCAL

OPTICS

BASIC TYPE (✓)
- Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (✓)
- Scalar ✓ Vector ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (✓)

	1D	2D
Compact Region		✓
Annular Region		✓

FIELD SYMMETRY RESTRICTIONS? None

MIRROR SHAPE(S) ALLOWED (✓)
- Square ___ Circular ✓ Strip ___
- Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (✓)
- Fixed Single Resonator Geometry ___
- Fixed Multiple Resonator Geometries ___
- Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		✓
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	✓
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)	✓	

- Other (specify) Midpoint Rule: Com/Ann.

CONVERGENCE TECHNIQUE (✓)
- Power Comparison ✓ Field Comparison ___
- Other ___

ACCELERATION ALGORITHMS USED? ___
- Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓)
- Prony ✓
- Other ___

RESONATOR TYPE (✓) Standing Wave ✓
- Traveling Wave (Ring) ✓ Reverse TW ___

BRANCH (✓) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (✓)
- Flat Mirrors ✓ Spherical Mirrors ✓
- Cylindrical Mirrors ___ Telescopes ✓
- Scraper Mirrors ✓

	Waxicons	Reflaxicons
Axicons		
Arbitrary	✓	✓
Linear		
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

- Deformable Mirrors ✓
- Spatial Filters ✓ Gratings ___
- Other Elements ___

GAIN MODELS (✓) Bare Cavity Only ___
- Simple Saturated Gain ✓ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (✓)
- Mirror Tilt ✓ Decentration ✓
- Aberrations/Thermal Distortions
- Arbitrary ✓
- Selected (specify) ___
- Reflectivity Loss ___
- Output Coupler Edges Rolled ___
- Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (✓)
- Medium Index Variation ✓
- Gas Absorption ✓
- Overlapped Beams ___
- Other General medium in homogeneities

FAR FIELD MODELS (✓) Beam Steering Removal ✓
- Optimal Focal Search ✓ Beam Quality ✓
- Other Beam phase cleanup system model.

KINETICS

AEROKNS

GAIN REGION MODELED (✓)
- Compact Region ___ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region ___ Annular Region CY

KINETICS GRID DIMENSIONALITY (✓)

	1D	2D	3D
Compact Region			
Annular Region	✓		

GAIN REGION SYMMETRY RESTRICTIONS
- Gain Vary Along Optic Axes? ___ Flow Direction? ✓

PULSED ___ CW ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (✓)
- $\{X + Y_2 \quad YX + Y\}$
- $\{Y + X_2 \quad YX + X\}$
- Cold $(F + H_2)$ ✓
- Hot $(H + F_2)$ ✓ Chain $(F + H_2 \& H + F_2)$ ✓
- Other (specify) ___

Y^X	F	Cl	Br	I
H	✓			
D	✓			

ENERGY TRANSFER MODES MODELED (✓) Reference
- V-T ✓ Cohen
- V-R
- V-V ✓ Cohen
- Other ___

Single Line Model (✓) ___

Multiline Model (✓) ✓

Assumed Rotational Population Distribution State (✓)
- Equilibrium ✓ Nonequilibrium ___

Number of Laser Lines Modeled ≤ 12

Source of Rate Coefficients Used in Code Handbook of Chemical Lasers.

LINE PROFILE MODELS (✓)
- Doppler Broadening ✓
- Collisional Broadening ✓
- Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (✓)
- Cylindrical, Radially Flowing ✓
- Rectangular, Linearly Flowing ___
- Other ___

COORDINATE SYSTEM CY

FLUID GRID DIMENSION (✓) 1D ✓ 2D ___ 3D ___

FLOW FIELD MODELED (✓)
- Laminar ___ Turbulent ___
- Other Scheduled mixing.

BASIC MODELING APPROACH (✓)
- Premixed ___ Mixing ✓
- Other (specify) ___

References for Approach Used ALOS Final Report

THERMAL DRIVER MODELED (✓)
- Arc Heater ___ Combustor ___
- Shock Tube ___ Resistance Heater ___
- Other Not modeled.

F-ATOM DISSOCIATION FROM (✓)
- F_2 ✓ SF_6 ✓
- Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? *

DILUENTS MODELED He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (✓)
- Nozzle Boundary Layers ✓ Shock Waves ___
- Prereactions (thermal blockage) ___ Turbulence ___
- Other (specify) Trip

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)
- Media Index Variations ✓
- Other (specify) ___

* By equilibrium thermochemistry

CODE NAME ROPTICS

CODE TYPE: Optical and Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Study interaction between rotational nonequilibrium kinetics and optical resonator geometry. Also see NORO-I.

ASSESSMENT OF CAPABILITIES: Since kinetic-fluid dynamic model is qualitative, code provides qualitative understanding of nonlinear interactions between kinetics, fluid dynamics, and optical resonator.

ASSESSMENT OF LIMITATIONS: Qualitative kinetics and fluid dynamics; strip minor resonator model (developed by Bell Aerospace Textron) models two mirror stable and unstable resonators.

OTHER UNIQUE FEATURES: Can take up to 30 lines; because of rotational nonequilibrium kinetics, predicts which lines will lase.

ORIGINATOR/KEY CONTACT:

Name: L.H. Sentman Phone: (217) 333-1834

Organization: Department of Aeronautical and Astronautical Engineering, University of Illinois

Address: 101 Transportation Building, Urbana, Illinois 61801

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (RP) Applied Optics 17, 2244 (1978).

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Bell Aerospace TEXTRON

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed):

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job		150 sec/iteration*
Large Job		

Approximate Number of FORTRAN Lines

* typically takes 15 iterations to converge.

CODE NAME: ROPTICS

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ✓ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ___

MIRROR SHAPE(S) ALLOWED (√)
Square ___ Circular ___ Strip ✓
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ✓
Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√)
Power Comparison ✓ Field Comparison ✓
Other P chem/P loss total optics.

ACCELERATION ALGORITHMS USED? ___
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√) Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ___ Spherical Mirrors ___
Cylindrical Mirrors ✓ Telescopes ___
Scraper Mirrors ___

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify):		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ___
Simple Saturated Gain ___ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ___ Decentration ___
Aberrations/Thermal Distortions:
Arbitrary ___
Selected (specify) ___
Reflectivity Loss ___
Output Coupler Edges: Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ___
Optimal Focal Search ___ Beam Quality ___
Other ___

KINETICS

GAIN REGION MODELED (√):
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED ___ CW ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$\left\{ \begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array} \right.$

X	F	Cl	Br	I
H	✓			
D				

Cold (F + H_2): ___
Hot (H + F_2): ___ Chain (F + H_2 & H + F_2) ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ✓
V-R ✓
V-V ___
Other ___

Single Line Model (√) ___
Multiline Model (√) ✓

Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ✓

Number of Laser Lines Modeled Predicts which lines will lase.

Source of Rate Coefficients Used in Code Cohen HF rate package, Hinchen's rotational relaxation data. Polanyi's pumping distribution.

LINE PROFILE MODELS (√)
Doppler Broadening ✓
Collisional Broadening ___
Other (specify) Voight profile.

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___

FLUID GRID DIMENSION (√) 1D ___ 2D ___ 3D ___

FLOW FIELD MODELED (√)
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√)
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ___
Other (specify) ___

CODE NAME: ROTKIN

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Prediction of HR/DF chemical laser performance based on coupled rate equation analysis of chemical, vibrational, rotational, and radiative transfer.

ASSESSMENT OF CAPABILITIES: Accurate prediction of laser spectra results from rotational nonequilibrium feature of kinetic analysis. Can vary mixing rate and schedules of flow variables to approximate certain physical effects (e.g. boundary layers, shock, etc.) Geometrical optics is used.

ASSESSMENT OF LIMITATIONS: Fabry-Perot resonator analysis is one-dimensional; fluid dynamic analysis is of one-dimensional, scheduled mixing variety.

OTHER UNIQUE FEATURES: Scheduled mixing model with different mixing lengths for primary and secondary mixing zones. Allows use of linear, exponential, or tabular rates.

ORIGINATOR/KEY CONTACT:

Name: R. J. Hall   Phone: (203) 727-7349

Organization: United Technologies Research Center

Address: Silver Lane, E. Hartford, Connecticut 06108

AVAILABLE DOCUMENTATION: (T = Theory, U - User, RP = Relevant Publication): (RP) R. J. Hall, "Rotational Nonequilibrium and Line-Selected Operation in CW DF Chemical Lasers", IEEE JQE, QE-12, 453 (1976).

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: UTRC

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): Univac 1110

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job		
Typical Job	Same for all: 110K	~ 60-90
Large Job		

Approximate Number of FORTRAN Lines: 2000

CODE NAME: ROTKIN

OPTICS

BASIC TYPE (✓)
- Physical Optics ____ Geometrical ✓

FIELD (POLARIZATION) REPRESENTATION (✓)
- Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (✓)

	1D	2D
Compact Region	✓	
Annular Region	✓	

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (✓)
- Square ____ Circular ____ Strip ✓
- Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (✓)
- Fixed Single Resonator Geometry ✓ (Fabry-Perot)
- Fixed Multiple Resonator Geometries ____
- Modular Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

	VEA	ANN AR
Fresnel Integral Algorithms		
With Re... Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

- Other (specify) ____

CONVERGENCE TECHNIQUE (✓)
- Power Comparison ____ Field Comparison ____
- Other ____

ACCELERATION ALGORITHMS USED? ____
- Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓):
- Prony ____
- Other ____

RESONATOR TYPE (✓): Standing Wave ✓
- Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (✓) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (✓)
- Flat Mirrors ✓ Spherical Mirrors ____
- Cylindrical Mirrors ____ Telescopes ____
- Scraper Mirrors ____

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

- Deformable Mirrors ____
- Spatial Filters ____ Gratings ____
- Other Elements ____

GAIN MODELS (✓): Bare Cavity Only ____
- Simple Saturated Gain ____ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (✓)
- Mirror Tilt ____ Decentration ____
- Aberrations/Thermal Distortions
  - Arbitrary ____
  - Selected (specify) ____
- Reflectivity Loss ✓
- Output Coupler Edges Rolled ____
  - Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (✓)
- Medium Index Variation ____
- Gas Absorption ____
- Overlapped Beams ____
- Other ____

FAR FIELD MODELS (✓) Beam Steering Removal ____
- Optimal Focal Search ____ Beam Quality ____
- Other ____

KINETICS

GAIN REGION MODELED (✓)
- Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (✓)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
- Gain Vary Along Optic Axes? ____ Flow Direction? ✓

PULSED ____ CW ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (✓)

$\left\{\begin{array}{ll} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{array}\right\}$

Y^X	F	Cl	Br	I
H	✓			
D	✓			

- Cold $(F + H_2)$ ✓
- Hot $(H + F_2)$ ____ Chain $(F + H_2 \& H + F_2)$ ____
- Other (specify) ____

ENERGY TRANSFER MODES MODELED (✓) Reference
- V-T ✓
- V-R ✓
- V-V ✓
- Other ____
- Single Line Model (✓) ____
- Multiline Model (✓) ✓
- Assumed Rotational Population Distribution State (✓)
  - Equilibrium ____ Nonequilibrium ✓
- Number of Laser Lines Modeled Up to 68.
- Source of Rate Coefficients Used in Code ALFA kinetics.

LINE PROFILE MODELS (✓)
- Doppler Broadening ✓
- Collisional Broadening ✓
- Other (specify) ✓ (Voight)

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (a... type) (✓)
- Cylindrical Radially Flowing ✓
- Rectangular Linearly Flowing ✓
- Other ____

COORDINATE SYSTEM Cartesian or cylindrical

FLUID GRID DIMENSION (✓) 1D ✓ 2D ____ 3D ____

FLOW FIELD MODELED (✓)
- Laminar ✓ Turbulent ✓
- Other Scheduled mixing model.

BASIC MODELING APPROACH (✓)
- Premixed ____ Mixing ✓
- Other (specify) Scheduled mixing model with different mixing lengths for different zones.
- References for Approach Used ____

THERMAL DRIVER MODELED (✓)
- Arc Heater ____ Combustor ____
- Shock Tube ____ Resistance Heater ____
- Other ____

F ATOM DISSOCIATION FROM (✓)
- F_2 ____ SF_6 ____
- Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (✓)
- Nozzle Boundary Layers ____ Shock Waves ____
- Prereactions (thermal blockage) ____ Turbulence ____
- Other (specify) Can vary mixing rate, schedules of flow variables to approximate above effects.

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)
- Media Index Variations ____
- Other (specify) ____

CODE NAME: SAIC2D

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Provide capability of modeling high-order modes in cylindrical/annular optical resonators.

ASSESSMENT OF CAPABILITIES: Provides beam intensity and phase distribution throughout any cylindrical/annular resonator system. Determine effects of system perturbations of these distributions.

ASSESSMENT OF LIMITATIONS: Limited to analysis of beams with azimuthal modes and compact region Fresnel numbers < 10.

OTHER UNIQUE FEATURES: Models HSURIA and traveling wave annular ring resonator

ORIGINATOR/KEY CONTACT:

Name: Jerry Long
Phone: (404) 955-2663
Organization: Science Applications, Inc.
Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION: (T - Theory, U - User, RP - Relevant Publication): (RP) E. A. Sziklas and A. E. Siegman, Applied Optics 14, 1874 (1975).

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): Incorporate generalized axicon/reflaxicon model.

Ownership?: U.S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): Cyber 175/176

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: Requires 370K or virtual memory computer. Some CDC FORTRAN dependent code.

SELF-CONTAINED?: Yes, except as noted below.

Other Codes Required (name, purpose): Requires input from kinetics calculations on a subroutine to do gain calculations for power extraction option. (See GCAL.)

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	370K	250-300
Typical Job:	370K	300-500
Large Job:	370K	500-2000

Approximate Number of FORTRAN Lines: 3000

CODE NAME: SAIC2D

OPTICS

BASIC TYPE (✓)
Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (✓)
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region Ca Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (✓)

	1D	2D
Compact Region		✓ *
Annular Region	✓ #	✓ +

FIELD SYMMETRY RESTRICTIONS? 1-16 Azimuthal modes in annular regions

MIRROR SHAPE(S) ALLOWED (✓)
Square ✓ Circular ✓ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (✓)
Fixed, Single Resonator Geometry ____
Fixed, Multiple Resonator Geometries ____
Modular, Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

	[illegible]	[illegible]
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)	✓	
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Radial asymptotic expansion in annular region

CONVERGENCE TECHNIQUE (✓)
Power Comparison ✓ Field Comparison ✓
Other ____

ACCELERATION ALGORITHMS USED? Yes
Technique Field and gain averaging

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓)
Prony ____
Other ____

RESONATOR TYPE (✓) Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ✓

BRANCH (✓) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (✓)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ____ Telescopes ✓
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear	✓	✓
Parabola-Parabola	✓	✓
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ✓
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (✓): Bare Cavity Only ____
Simple Saturated Gain ✓ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (✓):
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ✓
Selected (specify) Intensity mapping & bowing
Reflectivity Loss ✓
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (✓)
Medium Index Variation ✓
Gas Absorption ✓
Overlapped Beams ✓
Other ____

FAR-FIELD MODELS (✓) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ____

KINETICS

GAIN REGION MODELED (✓)
Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (✓)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED ____ **CW** ____ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (✓)
$\left\{ \begin{matrix} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{matrix} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold ($F + H_2$) ____
Hot ($H + F_2$) ____ Chain ($F + H_2$ & $H + F_2$) ____
Other (specify) ____

ENERGY TRANSFER MODES MODELED (✓) Reference
V-T ____
V-R ____
V-V ____
Other ____

Single Line Model (✓) ____
Multiline Model (✓) ____
Assumed Rotational Population Distribution State (✓)
Equilibrium ____ Nonequilibrium ____
Number of Laser Lines Modeled ____
Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (✓)
Doppler Broadening ____
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(✓)**
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (✓): 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (✓)
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (✓)
Premixed ____ Mixing ____
Other (specify) ____
References for Approach Used ____

THERMAL DRIVER MODELED (✓)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F-ATOM DISSOCIATION FROM (✓)
F_2 ____ SF_6 ____
Other (specify) ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (✓)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)
Media Index Variations ____
Other (specify) ____

* 128 x 128 #8192 +8192/NL

CODE NAME SAIC2DV

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Provide accurate, cost-effective method of cylindrical/annular optical resonator mode and power extraction analysis and determine the effect of various design perturbations on these parameters. (This code is a vectorized version of SAIC2D.)

ASSESSMENT OF CAPABILITIES: Provides beam intensity and phase distributions throughout any cylindrical/annular resonator system. Determine effects of system perturbations on these distributions.

ASSESSMENT OF LIMITATIONS: Limited to analysis of beams with 1-32 azimuthal modes and compact region Fresnel numbers < 30.

OTHER UNIQUE FEATURES: Models HSURIA and traveling wave annular resonator.

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION: (T - Theory, U - User, RP - Relevant Publication): (RP) E. A. Sziklas and A. E. Siegman, Applied Optics 14, 1874 (1975)

STATUS

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): To complete optimization of vectorized routines

Ownership?: U.S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CYBER 203

TRANSPORTABLE?: No

Machine Dependent Restrictions: Usus CYBER 203 vector algorithms

SELF-CONTAINED?: Yes, except as noted below.

Other Codes Required (name, purpose): Requires imput from kinetics calculations or a subroutine to do gain calculations for power extraction option (See GCAL).

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	1000K	20 CYBER 203
Typical Job	1000K	100 CYBER 203
Large Job	1000K	500-1000 CYBER 203

Approximate Number of FORTRAN Lines: 3000

CODE NAME SAIC2DV

OPTICS

BASIC TYPE (√)

Physical Optics √ Geometrical

FIELD (POLARIZATION) REPRESENTATION (√)

Scalar √ Vector

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region Ca Annular Region cy

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		(1)
Annular Region	(2)	(3)

FIELD SYMMETRY RESTRICTIONS? 1-64 azimuthal modes in annular regions

MIRROR SHAPE(S) ALLOWED (√)

Square √ Circular √ Strip

Rectangular Elliptical Arbitrary

CONFIGURATION FLEXIBILITY (√)

Fixed Single Resonator Geometry

Fixed Multiple Resonator Geometries

Modular Multiple Resonator Geometries √

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)	√	
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Radial asymptotic expansion in annular region

CONVERGENCE TECHNIQUE (√)

Power Comparison √ Field Comparison √

Other

ACCELERATION ALGORITHMS USED?

Technique

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)

Prony

Other

RESONATOR TYPE (√) Standing Wave √

Traveling Wave (Ring) √ Reverse TW √

BRANCH (√) Positive √ Negative √

OPTICAL ELEMENT MODELS INCLUDED (√)

Flat Mirrors √ Spherical Mirrors √

Cylindrical Mirrors Telescopes √

Scraper Mirrors √

	Axicons	Reflaxicons
Axicons		
Arbitrary		
Linear	√	√
Parabola Parabola	√	√
Variable Cone Offset		
Other (specify)		

Deformable Mirrors √

Spatial Filters Gratings

Other Elements

GAIN MODELS (√) Bare Cavity Only

Simple Saturated Gain √ Detailed Gain √

BARE CAVITY FIELD MODIFIER MODELS (√)

Mirror Tilt √ Decentration √

Aberrations/Thermal Distortions

Arbitrary √

Selected (specify) Intensity mapping & bowing

Reflectivity Loss √

Output Coupler Edges Rolled

Serrated Other

LOADED CAVITY FIELD MODIFIER MODELS (√)

Medium Index Variation √

Gas Absorption √

Overlapped Beams √

Other

FAR FIELD MODELS (√) Beam Steering Removal √

Optimal Focal Search √ Beam Quality √

Other

KINETICS

GAIN REGION MODELED (√)

Compact Region Annular Region

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region Annular Region

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? Flow Direction?

PULSED CW KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$X + Y_2 \quad YX + Y$

$Y + X_2 \quad YX + X$

Y^X	F	Cl	Br	I
H				
D				

Cold ($F + H_2$)

Hot ($H + F_2$) Chain ($F + H_2$ & $H + F_2$)

Other (specify)

ENERGY TRANSFER MODES MODELED (√) Reference

V-T

V-R

V-V

Other

Single Line Model (√)

Multiline Model (√)

Assumed Rotational Population Distribution State (√)

Equilibrium Nonequilibrium

Number of Laser Lines Modeled

Source of Rate Coefficients Used in Code

LINE PROFILE MODELS (√)

Doppler Broadening

Collisional Broadening

Other (specify)

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)

Cylindrical Radially Flowing

Rectangular Linearly Flowing

Other

COORDINATE SYSTEM

FLUID GRID DIMENSION (√) 1D 2D 3D

FLOW FIELD MODELED (√)

Laminar Turbulent

Other

BASIC MODELING APPROACH (√)

Premixed Mixing

Other (specify)

References for Approach Used

THERMAL DRIVER MODELED (√)

Arc Heater Combustor

Shock Tube Resistance Heater

Other

F-ATOM DISSOCIATION FROM (√)

F_2 SF_6

Other (specify)

F-ATOM CONCENTRATION DETERMINED FROM MODEL?

DILUENTS MODELED

MODELS EFFECTS ON MIXING RATE DUE TO (√)

Nozzle Boundary Layers Shock Waves

Prereactions (thermal blockage) Turbulence

Other (specify)

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)

Media Index Variations

Other (specify)

(3) 3276874

CODE NAME SAIFHT

CODE TYPE Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE Provide accurate, cost-effective method of cylindrical/annular optical resonator parameter analysis including power extraction for use in overall system optimization.

ASSESSMENT OF CAPABILITIES Provides beam intensity and phase distributions throughout any cylindrical/annular resonator system.

ASSESSMENT OF LIMITATIONS Models only circular beams which can be described with 1 - 8 azimuthal modes.

OTHER UNIQUE FEATURES Models standing wave and annular ring resonators, compact unstable confocal resonators, confocal and non-confocal HSURIA.

ORIGINATOR/KEY CONTACT

Name: Jerry Long Phone (404) 955-2663

Organization Science Applications, Inc.

Address 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication) (T) HF Laser Subsystem Technology Assessment (DARPA Interim Report), SAI, Atlanta, Georgia, July, 1979 (CONFIDENTIAL).

(RP) E. A. Sziklas and A. E. Siegman, Applied Optics 14, 1874 (1975).

STATUS:

Operational Currently? Yes

Under Modification? Yes

Purpose(s) To provide generalized axicon/reflaxicon model.

Ownership? U.S. Government

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed) Cyber 175, 176

TRANSPORTABLE? Yes

Machine Dependent Restrictions Requires machine with minimum of 370K or virtual memory; some lines in code are CDC FORTRAN dependent.

SELF-CONTAINED? Yes, except as noted below.

Other Codes Required (name, purpose) Requires input from kinetics calculations or a subroutine to do gain calculations for power extraction (See GCAL).

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job	370K	10 - 50
Typical Job	370K	50 - 100
Large Job	370K	100 - 300

Approximate Number of FORTRAN Lines 2500

CODE NAME: SAIFHT

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian cylindrical etc.)
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region	8192	4096*
Annular Region	[illegible]92	4096*

FIELD SYMMETRY RESTRICTIONS? 1-8 azimuthal modes

MIRROR SHAPE(S) ALLOWED (√)
Square ____ Circular ✓ Strip ____
Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (√)
Fixed Single Resonator Geometry ____
Fixed Multiple Resonator Geometries ____
Modular Multiple Resonator Geometries ✓

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)	✓	
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) Radial asymptotic expansion in annular region

CONVERGENCE TECHNIQUE (√)
Power Comparison ✓ Field Comparison ✓
Other ____

ACCELERATION ALGORITHMS USED? Yes
Technique Field and gain averaging

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√)
Prony ____
Other ____

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ✓ Reverse TW ✓

BRANCH (√) Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ✓ Spherical Mirrors ✓
Cylindrical Mirrors ____ Telescopes ✓
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear	✓	✓
Parabola Parabola	✓	✓
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____
Spatial Filters ____ Gratings ____
Other Elements ____

GAIN MODELS (√) Bare Cavity Only ____
Simple Saturated Gain ✓ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√)
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions
Arbitrary ✓
Selected (specify) intensity mapping & bowing
Reflectivity Loss ✓
Output Coupler Edges Rolled ____
Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (√)
Medium Index Variation ✓
Gas Absorption ✓
Overlapped Beams ✓
Other ____

FAR FIELD MODELS (√) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ____

KINETICS

GAIN REGION MODELED (√)
Compact Region ____ Annular Region ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ____ Annular Region ____

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ____ Flow Direction? ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$\left\{ \begin{matrix} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{matrix} \right\}$

Y^X	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ____
Hot $(H + F_2)$ ____ Chain $(F + H_2$ & $H + F_2)$ ____
Other (specify) ____

ENERGY TRANSFER MODES MODELED (√) Reference
V T ____
V R ____
V V ____
Other ____
Single Line Model (√) ____
Multiline Model (√) ____
Assumed Rotational Population Distribution State (√)
Equilibrium ____ Nonequilibrium ____
Number of Laser Lines Modeled ____
Source of Rate Coefficients Used in Code ____

LINE PROFILE MODELS (√)
Doppler Broadening ____
Collisional Broadening ____
Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical, Radially Flowing ____
Rectangular, Linearly Flowing ____
Other ____

COORDINATE SYSTEM ____

FLUID GRID DIMENSION (√) 1D ____ 2D ____ 3D ____

FLOW FIELD MODELED (√)
Laminar ____ Turbulent ____
Other ____

BASIC MODELING APPROACH (√)
Premixed ____ Mixing ____
Other (specify) ____
References for Approach Used ____

THERMAL DRIVER MODELED (√)
Arc Heater ____ Combustor ____
Shock Tube ____ Resistance Heater ____
Other ____

F ATOM DISSOCIATION FROM (√)
F_2 ____ SF_6 ____
Other (specify) ____

F ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED ____

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers ____ Shock Waves ____
Prereactions (thermal blockage) ____ Turbulence ____
Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations ____
Other (specify) ____

* per NL

CODE NAME SAICC

CODE TYPE: Gasdynamics and Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: (1) To correlate and analyze closed cavity data. (2) To optimize operating conditions and geometric configurations. (3) To generate gain algorithms for wave optics analysis. Lasing and chemical kinetics modeling are included. Generates gasdynamic/kinetic profiles for gain algorithm (GCAL).

ASSESSMENT OF CAPABILITIES: Model has been applied to a wide variety of source flow nozzles and has correlated the available closed cavity data base well. Utilizes 1-D gasdynamics to model the 3-D flowfield of source flow nozzles. Includes effects of base pressure, mixing rate and source flow geometry. Treats expansion plane of source flow as two distinct regions, a base pressure region and a pure source flow region.

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES: Models HF or DF lasing. Single line lasing is modeled, but multi-line corrections are made to account for photon production at all levels. Utilizes either constant gain approximation or laser rate equation.

ORIGINATOR/KEY CONTACT:

Name: Kerry E. Patterson Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION (T Theory, U User, RP Relevant Publication): (T) HF Laser Subsystem Technology Assessment (DARPA Interim Report), Science Applications, Inc., Atlanta, Georgia, July, 1979, Section 3.

STATUS

Operational Currently? Yes

Under Modification? Yes

Purpose(s): To extend kinetics model to full multi-line capability.

Ownership? U.S. Government

Proprietary? No

MACHINE/OPERATING SYSTEM (on which installed): Cyber 175

TRANSPORTABLE? Yes

Machine Dependent Restrictions: None

SELF-CONTAINED? Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS

	Core Size (Octal Words)	Execution Time (Sec CDC 7600)
Small Job		
Typical Job		10 - 20 (gasdynamic); 5 - 15 (kinetics)
Large Job		

Approximate Number of FORTRAN Lines: 4000 (gasdynamics); 900 (kinetics)

CODE NAME [illegible]

OPTICS

BASIC TYPE (✓)

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (✓)

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (✓)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ____

MIRROR SHAPE(S) ALLOWED (✓)

Square ____ Circular ____ Strip ____

Rectangular ____ Elliptical ____ Arbitrary ____

CONFIGURATION FLEXIBILITY (✓)

Fixed, Single Resonator Geometry ____

Fixed, Multiple Resonator Geometries ____

Modular, Multiple Resonator Geometries ____

PROPAGATION TECHNIQUE

Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel Kirchhoff (GFK)		

Other (specify) ____

CONVERGENCE TECHNIQUE (✓)

Power Comparison ____ Field Comparison ____

Other ____

ACCELERATION ALGORITHMS USED? ____

Technique ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (✓)

Prony ____

Other ____

RESONATOR TYPE (✓) Standing Wave ____

Traveling Wave (Ring) ____ Reverse TW ____

BRANCH (✓) Positive ____ Negative ____

OPTICAL ELEMENT MODELS INCLUDED (✓)

Flat Mirrors ____ Spherical Mirrors ____

Cylindrical Mirrors ____ Telescopes ____

Scraper Mirrors ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ____

Spatial Filters ____ Gratings ____

Other Elements ____

GAIN MODELS (✓) Bare Cavity Only ____

Simple Saturated Gain ____ Detailed Gain ____

BARE CAVITY FIELD MODIFIER MODELS (✓)

Mirror Tilt ____ Decentration ____

Aberrations / Thermal Distortions

Arbitrary ____

Selected (specify) ____

Reflectivity Loss ____

Output Coupler Edges Rolled ____

Serrated ____ Other ____

LOADED CAVITY FIELD MODIFIER MODELS (✓)

Medium Index Variation ____

Gas Absorption ____

Overlapped Beams ____

Other ____

FAR FIELD MODELS (✓) Beam Steering Removal ____

Optimal Focal Search ____ Beam Quality ____

Other ____

KINETICS

GAIN REGION MODELED (✓)

Compact Region ✓ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region Ca Annular Region Cy

KINETICS GRID DIMENSIONALITY (✓)

	1D	2D	3D
Compact Region		✓	
Annular Region		✓	

GAIN REGION SYMMETRY RESTRICTIONS

Gain Vary Along Optic Axes? No Flow Direction? Yes

PULSED ____ CW ✓ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (✓)

$X + Y_2 \quad YX + Y$

$Y + X_2 \quad YX + X$

X^Y	F	Cl	Br	I
H	✓			
D	✓			

Cold $(F + H_2)$ ✓

Hot $(H + F_2)$ ✓ Chain $(F + H_2$ & $H + F_2)$ ✓

Other (specify) ____

ENERGY TRANSFER MODES MODELED (✓) Reference

V T ✓ Cohen & Bott (1976)

V R ____

V V ____

Other ____

Single Line Model (✓) ✓*

Multiline Model (✓) ____

Assumed Rotational Population Distribution State (✓)

Equilibrium ____ Nonequilibrium ____

Number of Laser Lines Modeled ____

Source of Rate Coefficients Used in Code

Cohen & Bott (1976)

LINE PROFILE MODELS (✓)

Doppler Broadening ✓

Collisional Broadening ____

Other (specify) ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (✓)

Cylindrical, Radially Flowing ✓

Rectangular, Linearly Flowing ✓

Other Source flow nozzles

COORDINATE SYSTEM Cartesian or cylindrical

FLUID GRID DIMENSION (✓) 1D ____ 2D ____ 3D ✓*

FLOW FIELD MODELED (✓)

Laminar ✓ Turbulent ✓

Other ____

BASIC MODELING APPROACH (✓)

Premixed ____ Mixing ____

Other (specify) Flame sheet approach

References for Approach Used ____

THERMAL DRIVER MODELED (✓)

Arc Heater ____ Combustor ✓

Shock Tube ____ Resistance Heater ____

Other ____

F ATOM DISSOCIATION FROM (✓)

F_2 ✓ SF_6 ____

Other (specify) NF_3

F ATOM CONCENTRATION DETERMINED FROM MODEL? Yes

DILUENTS MODELED N_2, He

MODELS EFFECTS ON MIXING RATE DUE TO (✓)

Nozzle Boundary Layers ✓ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ✓

Other (specify) ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (✓)

Media Index Variations In flow direction

Other (specify) ____

AD-A093 540   BDM CORP ALBUQUERQUE NM   F/G 20/5

CHEMICAL LASER COMPUTER CODE SURVEY,(U)

DEC 80 C M WIGGINS, D N MANSELL, P B ULRICH   N00173-79-C-0109

UNCLASSIFIED   NRL-8450   NL

3 OF 3

END

DATE FILMED

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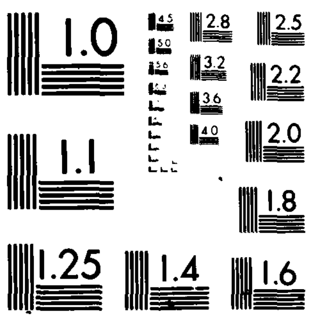


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

CODE NAME: SAI1D

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Provide accurate, cost-effective method of linear optical resonator mode and power extraction analysis and the affect of various design perturbations on these parameters.

ASSESSMENT OF CAPABILITIES: Provides beam intensity and phase distribution throughout one transverse dimension in a linear resonator.

ASSESSMENT OF LIMITATIONS: Models only one transverse dimension and does not provide for any cross-coupling affects that may occur.

OTHER UNIQUE FEATURES: Models linear confocal and non-confocal positive and negative branch resonators.

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (RP) E. A. Sziklas and A. E. Siegman, Applied Optics 14, 1874 (1975).

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: U.S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): Cyber 175/176

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: Has some lines that are CDC FORTRAN dependent.

SELF-CONTAINED?: Yes, except as noted below.

Other Codes Required (name, purpose): Requires input from a kinetic calculation or a subroutine to do gain calculations for power extraction (See GCAL).

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:	200K	5 - 10
Typical Job:	200K	25 - 75
Large Job:	200K	100 - 200

Approximate Number of FORTRAN Lines: 2000

CODE NAME: SAI1D

OPTICS

BASIC TYPE (√)

Physical Optics ✓ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√):

Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):

Compact Region Ca Annular Region: ____

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region: * 8192	✓*	
Annular Region:		

FIELD SYMMETRY RESTRICTIONS?: +

MIRROR SHAPE(S) ALLOWED (√):

Square: ____ Circular: ____ Strip: ✓

Rectangular ____ Elliptical: ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):

Fixed, Single Resonator Geometry: ____

Fixed, Multiple Resonator Geometries: ____

Modular, Multiple Resonator Geometries: ✓

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms:		
With Kernel Averaging		
Gaussian Quadrature:		
Fast Fourier Transform (FFT):	✓	
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ____

CONVERGENCE TECHNIQUE (√):

Power Comparison: ✓ Field Comparison: ✓

Other: ____

ACCELERATION ALGORITHMS USED?: Yes

Technique: Field and gain averaging

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM:(√):

Prony: ____

Other: ____

RESONATOR TYPE (√): Standing Wave: ✓

Traveling Wave (Ring): ✓ Reverse TW: ✓

BRANCH (√): Positive: ✓ Negative: ✓

OPTICAL ELEMENT MODELS INCLUDED (√):

Flat Mirrors: ✓ Spherical Mirrors: ✓

Cylindrical Mirrors: ✓ Telescopes: ✓

Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ____

Spatial Filters: ✓ Gratings: ____

Other Elements: ____

GAIN MODELS (√): Bare Cavity Only: ____

Simple Saturated Gain: ✓ Detailed Gain: ✓ *

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt: ✓ Decentration: ✓

Aberrations/Thermal Distortions:

Arbitrary: ✓

Selected (specify): intensity mapping & power bowing

Reflectivity Loss: ✓

Output Coupler Edges: Rolled: ____

Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):

Medium Index Variation: ✓

Gas Absorption: ✓

Overlapped Beams: ✓

Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal: ✓

Optimal Focal Search: ✓ Beam Quality: ✓

Other: ____

KINETICS

GAIN REGION MODELED (√):

Compact Region: ____ Annular Region: ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region: ____ Annular Region: ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optic Axis?: ____ Flow Direction?: ____

PULSED: ____ **CW:** ____ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{ \begin{array}{l} X + Y_2 = YX + Y \\ Y + X_2 = YX + X \end{array} \right\}$

X✓	F	Cl	Br	I
H				
D				

Cold ($F + H_2$): ____

Hot ($H + F_2$): ____ Chain ($F + H_2$ & $H + F_2$): ____

Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference

V-T: ____

V-R: ____

V-V: ____

Other: ____

Single Line Model (√): ____

Multiline Model (√) ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____ Nonequilibrium: ____

Number of Laser Lines Modeled: ____

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**

Cylindrical, Radially Flowing: ____

Rectangular, Linearly Flowing: ____

Other: ____

COORDINATE SYSTEM: ____

FLUID GRID DIMENSION (√): 1D: ____ 2D: ____ 3D: ____

FLOW FIELD MODELED (√):

Laminar: ____ Turbulent: ____

Other: ____

BASIC MODELING APPROACH (√):

Premixed: ____ Mixing: ____

Other (specify): ____

References for Approach Used: ____

THERMAL DRIVER MODELED (√):

Arc Heater: ____ Combustor: ____

Shock Tube: ____ Resistance Heater: ____

Other: ____

F-ATOM DISSOCIATION FROM (√):

F_2: ____ SF_6: ____

Other (specify): ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ____

DILUENTS MODELED: ____

MODELS EFFECTS ON MIXING RATE DUE TO (√):

Nozzle Boundary Layers: ____ Shock Waves: ____

Preactions (thermal blockage): ____ Turbulence: ____

Other (specify): ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):

Media Index Variations: ____

Other (specify): ____

+ Not accurate for large cross-coupling effects * with GCAL

CODE NAME: SAI2D

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Modeling of rectangular linear resonators and optical trains.

ASSESSMENT OF CAPABILITIES: Provides beam intensity and phase distributions throughout a linear rectangular resonator system.

ASSESSMENT OF LIMITATIONS: Limited to a combined 2-dimensional sampling resolution of 8192 points (64 x 128).

OTHER UNIQUE FEATURES: Models compact unstable confocal (ABLE, MIRACL, MADS, HELWS) resonators.

ORIGINATOR/KEY CONTACT:

Name: Jerry Long Phone: (404) 955-2663

Organization: Science Applications, Inc.

Address: 6600 Powers Ferry Road, Suite 220, Atlanta, Georgia 30339

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (RP) E. A. Sziklas and A. E. Siegman, Applied Optics 14, 1874 (1975)

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: U.S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): Cyber 175/176

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: Contains some CDC FORTRAN dependent Code.

SELF-CONTAINED?: Yes, except as noted below.

Other Codes Required (name, purpose): Requires input from kinetics calculation or a subroutine to do gain calculations for power extraction options (See GCAL).

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	370K	100 - 200
Typical Job:	370K	200 - 500
Large Job:	370K	500 - 1000

Approximate Number of FORTRAN Lines: 2500

CODE NAME: SAI2D

OPTICS

BASIC TYPE (√)
Physical Optics √ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar √ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region Ca Annular Region: ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region NX · NY = 8192		√
Annular Region		

FIELD SYMMETRY RESTRICTIONS?: NONE

MIRROR SHAPE(S) ALLOWED (√):
Square: √ Circular: √ Strip: ___
Rectangular: √ Elliptical: √ Arbitrary: ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ___
Fixed, Multiple Resonator Geometries: ___
Modular, Multiple Resonator Geometries: √

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms:		
With Kernel Averaging		
Gaussian Quadrature:		
Fast Fourier Transform (FFT):	√	
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ___

CONVERGENCE TECHNIQUE (√):
Power Comparison: √ Field Comparison: √
Other: ___

ACCELERATION ALGORITHMS USED?: Yes
Technique: Field and gain averaging

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: ___
Other: ___

RESONATOR TYPE (√): Standing Wave: √
Traveling Wave (Ring): √ Reverse TW: √

BRANCH (√): Positive: √ Negative: √

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: √ Spherical Mirrors: √
Cylindrical Mirrors: √ Telescopes: √
Scraper Mirrors: √

	Waxicons	Reflaxicons
Axicons		
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: √
Spatial Filters: √ Gratings: ___
Other Elements: ___

GAIN MODELS (√): Bare Cavity Only: ___
Simple Saturated Gain: √ Detailed Gain: √ *

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: √ Decentration: √
Aberrations/Thermal Distortions:
Arbitrary: √
Selected (specify): Intensity mapping, √bowing
Reflectivity Loss: ___
Output Coupler Edges: Rolled: ___
Serrated: ___ Other: ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: √
Gas Absorption: √
Overlapped Beams: √
Other: ___

FAR-FIELD MODELS (√): Beam Steering Removal: √
Optimal Focal Search: √ Beam Quality: √
Other: ___

KINETICS

GAIN REGION MODELED (√):
Compact Region: ___ Annular Region: ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: ___ Annular Region: ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ___ Flow Direction?: ___

PULSED: ___ **CW:** ___ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 = YX + Y$
$Y + X_2 = YX + X$

X \ Y	F	Cl	Br	I
H				
D				

Cold ($F + H_2$): ___
Hot ($H + F_2$): ___ Chain ($F + H_2$ & $H + F_2$): ___
Other (specify): ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ___
V-R: ___
V-V: ___
Other: ___
Single Line Model (√): ___
Multiline Model (√): ___
Assumed Rotational Population Distribution State (√):
Equilibrium: ___ Nonequilibrium ___
Number of Laser Lines Modeled: ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
Cylindrical, Radially Flowing: ___
Rectangular, Linearly Flowing: ___
Other: ___

COORDINATE SYSTEM: ___

FLUID GRID DIMENSION (√): 1D: ___ 2D: ___ 3D: ___

FLOW FIELD MODELED (√):
Laminar: ___ Turbulent: ___
Other: ___

BASIC MODELING APPROACH (√):
Premixed: ___ Mixing: ___
Other (specify): ___
References for Approach Used: ___

THERMAL DRIVER MODELED (√):
Arc Heater: ___ Combustor: ___
Shock Tube: ___ Resistance Heater: ___
Other: ___

F-ATOM DISSOCIATION FROM (√):
F_2: ___ SF_6: ___
Other (specify): ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ___

DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ___ Shock Waves: ___
Prereactions (thermal blockage): ___ Turbulence: ___
Other (specify): ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ___
Other (specify): ___

* with GCAL

CODE NAME: SOS

CODE TYPE: Optics and Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: (Son-of-Spike); calculation of pulsed HF and DF chemical laser performance.

ASSESSMENT OF CAPABILITIES: Calculates solutions to coupled thermodynamic, chemical kinetic, and radiation transport equations for pulsed HF and DF lasers. Utilizes comprehensive model of chemical kinetics and includes rotational nonequilibrium. Treatment of rotational nonequilibrium allows very short computing time.

ASSESSMENT OF LIMITATIONS: Restricted to Fabry-Perot cavity.

OTHER UNIQUE FEATURES: The existing code is strictly a pulse code. Hence there are no flow-field features that are pertinent. However, a modification to be known as GSOS (Grandson-of-Spike) is now being debugged which will incorporate the DESALE-5 mixing model into SOS. The result will be an efficient CW code with rotation nonequilibrium.

ORIGINATOR/KEY CONTACT:

Name: Orig: J. Hough;Contact: M. Epstein Phone: (213) 648-6861

Organization: Aerophysics Laboratory, The Aerospace Corporation

Address: P. O. Box 92957, Los Angeles, California 90009

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) "Efficient Model for HF Lasers with Rotational Nonequilibrium," J.J.T. Hough, Aerospace Corporation, Rpt. SAMSO-TR-78-79, August 15, 1978; (U) "SPIKE: A Computer Model for the $H_2(D_2) + F_2$ Pulsed Chemical Laser", J.J.T. Hough, Aerospace Corporation, Rpt. SAMSO-TR-78-84, April 14, 1978. (T) "A Reveiw of Rate Coefficients in the $H_2 - F_2$ Chemical Laser System Supplement (1977)," Aerospace Corporation Rpt. SAMSO-TR-78-41, N. Cohen June 8, 1978.

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): Extension to CW case.

Ownership?: Aerospace Corporation

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		30
Typical Job:	6K	60
Large Job:		300

Approximate Number of FORTRAN Lines: 3200

CODE NAME: SOS

OPTICS

BASIC TYPE (√):
Physical Optics: ____ Geometrical: ✓

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: Ca Annular Region: ____

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region:		
Annular Region:		

FIELD SYMMETRY RESTRICTIONS?: ____

MIRROR SHAPE(S) ALLOWED (√):
Square: ____ Circular: ____ Strip: ____
Rectangular: ____ Elliptical: ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ✓
Fixed, Multiple Resonator Geometries: ____
Modular, Multiple Resonator Geometries: ____

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms.		
With Kernel Averaging		
Gaussian Quadrature:		
Fast Fourier Transform (FFT):		
Fast Hankel Transform (FHT):		
Gardner-Fresnel-Kirchhoff (GFK):		

Other (specify): ____

CONVERGENCE TECHNIQUE (√):
Power Comparison: ____ Field Comparison: ____
Other: ____

ACCELERATION ALGORITHMS USED?: ____
Technique: ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony: ____
Other: ____

RESONATOR TYPE (√): Standing Wave: ____
Traveling Wave (Ring): ____ Reverse TW: ____

BRANCH (√): Positive: ____ Negative: ____

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ✓ Spherical Mirrors: ____
Cylindrical Mirrors: ____ Telescopes: ____
Scraper Mirrors: ____

	Waxicons	Reflaxicons
Axicons		
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ____
Spatial Filters: ____ Gratings: ____
Other Elements: ____

GAIN MODELS (√): Bare Cavity Only: ____
Simple Saturated Gain: ____ Detailed Gain: ____

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ____ Decentration: ____
Aberrations/Thermal Distortions:
Arbitrary: ____
Selected (specify): ____
Reflectivity Loss: ____
Output Coupler Edges: Rolled: ____
Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ____
Gas Absorption: ____
Overlapped Beams: ____
Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal: ____
Optimal Focal Search: ____ Beam Quality: ____
Other: ____

KINETICS

GAIN REGION MODELED (√):
Compact Region: ✓ Annular Region: ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: Ca Annular Region: ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: No Flow Direction?: No

PULSED: ✓ **CW:** ____ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):

$X + Y_2 = YX + Y$
$Y + X_2 = YX + X$

X̸	F	Cl	Br	I
H	✓			
D	✓			

Cold ($F + H_2$): ✓
Hot ($H + F_2$): ✓ Chain ($F + H_2$ & $H + F_2$): ✓
Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ✓
V-R: ✓
V-V: ✓
Other: ____

Single Line Model (√): ____
Multiline Model (√): ✓

Assumed Rotational Population Distribution State (√):
Equilibrium: ____ Nonequilibrium: ✓

Number of Laser Lines Modeled: 150

Source of Rate Coefficients Used in Code: N. Cohen, SAMSO-TR-78-41, June 8, 1978.

LINE PROFILE MODELS (√):
Doppler Broadening: ____
Collisional Broadening: ____
Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):** None
Cylindrical, Radially Flowing: ____
Rectangular, Linearly Flowing: ____
Other: ____

COORDINATE SYSTEM: ____

FLUID GRID DIMENSION (√): 1D: ____ 2D: ____ 3D: ____

FLOW FIELD MODELED (√):
Laminar: ____ Turbulent: ____
Other: ____

BASIC MODELING APPROACH (√):
Premixed: ____ Mixing: ____
Other (specify): ____

References for Approach Used: ____

THERMAL DRIVER MODELED (√):
Arc Heater: ____ Combustor: ____
Shock Tube: ____ Resistance Heater: ____
Other: ____

F-ATOM DISSOCIATION FROM (√):
F_2: ____ SF_6: ____
Other (specify): ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ____

DILUENTS MODELED: ____

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ____ Shock Waves: ____
Precreactions (thermal blockage): ____ Turbulence: ____
Other (specify): ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ____
Other (specify): ____

CODE NAME: TDLCLRC*

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Performs 3-D wave optics resonator analysis of a positive branch confocal unstable resonator with rectangular spherical mirrors.

ASSESSMENT OF CAPABILITIES: Power extraction from an active DF medium. Off-axis geometry configuration. Apertures at all stations. 3-D plot capability. Kenetics and mixing calculations are performed with AEAOKNS. (See AEROKNS for additional details).

ASSESSMENT OF LIMITATIONS: No misalignment model. No Farfield model.

OTHER UNIQUE FEATURES: Resonator geometries modeled: positive branch unstable confocal linear resonator with rectangular spherical mirrors. Off-axis geometry capability.

ORIGINATOR/KEY CONTACT:
Name: Victor L. Gamiz Phone: (213) 884-3346
Organization: Rocketdyne, Laser Optics
Address: 6633 Canoga Ave., Canoga Park, California (91304)

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) High Power Testing of Optical Components (HIPTOC) Technical Proposal, Part III, Appendix B (V. L. Gamiz).

STATUS:
Operational Currently?: Yes
Under Modification?: No
Purpose(s):

Ownership?: Rocketdyne
Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: Yes
Machine Dependent Restrictions:

SELF-CONTAINED?:
Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	<250K	100
Typical Job:	<250K	500-1000
Large Job:	<250K	2000

Approximate Number of FORTRAN Lines: 8000

* 3-D Loaded Cavity Linear Resonator Code

CODE NAME: TDLCLRC

OPTICS

BASIC TYPE (√)
- Physical Optics: √ Geometrical: ____

FIELD (POLARIZATION) REPRESENTATION (√):
- Scalar: √ Vector: ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
- Compact Region: Ca Annular Region: N/A

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region:		√
Annular Region:		

FIELD SYMMETRY RESTRICTIONS?: None

MIRROR SHAPE(S) ALLOWED (√):
- Square: √ Circular: ____ Strip: ____
- Rectangular: √ Elliptical: ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):
- Fixed, Single Resonator Geometry: √
- Fixed, Multiple Resonator Geometries: ____
- Modular, Multiple Resonator Geometries: ____

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms:		
With Kernel Averaging	√	
Gaussian Quadrature:		
Fast Fourier Transform (FFT):	√	
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

- Other (specify): ____

CONVERGENCE TECHNIQUE (√):
- Power Comparison: ____ Field Comparison: √
- Other: ____

ACCELERATION ALGORITHMS USED?: Yes
- Technique: Mirror Edge Tapering.

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM:(√):
- Prony: N/A
- Other: ____

RESONATOR TYPE (√): Standing Wave ____
- Traveling Wave (Ring): √ Reverse TW: ____

BRANCH (√): Positive: √ Negative: ____

OPTICAL ELEMENT MODELS INCLUDED (√):
- Flat Mirrors: ____ Spherical Mirrors: √
- Cylindrical Mirrors: ____ Telescopes: ____
- Scraper Mirrors: ____

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

- Deformable Mirrors: ____
- Spatial Filters: ____ Gratings: ____
- Other Elements: ____

GAIN MODELS (√): Bare Cavity Only: ____
- Simple Saturated Gain: ____ Detailed Gain: √

BARE CAVITY FIELD MODIFIER MODELS (√):
- Mirror Tilt: ____ Decentration: ____
- Aberrations/Thermal Distortions:
  - Arbitrary: ____
  - Selected (specify): ____
- Reflectivity Loss: √
- Output Coupler Edges: Rolled: √
  - Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):
- Medium Index Variation: ____
- Gas Absorption: ____
- Overlapped Beams: ____
- Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal: ____
- Optimal Focal Search: ____ Beam Quality: ____
- Other: ____

KINETICS

AEROKNS

GAIN REGION MODELED (√):
- Compact Region: ____ Annular Region: √

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region: ____ Annular Region: CY

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:	√		

GAIN REGION SYMMETRY RESTRICTIONS:
- Gain Vary Along Optic Axes?: ____ Flow Direction?: √

PULSED: ____ **CW:** √ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{ \begin{matrix} X + Y_2 = YX + Y \\ Y + X_2 = YX + X \end{matrix} \right\}$

	F	Cl	Br	I
H	√			
D	√			

- Cold (F + H_2): √
- Hot (H + F_2): √ Chain (F + H_2 & H + F_2): √
- Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference
- V-T: √ Cohen
- V-R: ____
- V-V: √ Cohen
- Other: ____

- Single Line Model (√): ____
- Multiline Model (√): √
- Assumed Rotational Population Distribution State (√):
  - Equilibrium: √ Nonequilibrium: ____
- Number of Laser Lines Modeled: ≤ 12
- Source of Rate Coefficients Used in Code: Handbook of Chemical Lasers.

LINE PROFILE MODELS (√):
- Doppler Broadening: √
- Collisional Broadening: √
- Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
- Cylindrical, Radially Flowing: √
- Rectangular, Linearly Flowing: ____
- Other: ____

COORDINATE SYSTEM: CY

FLUID GRID DIMENSION (√): 1D: √ 2D: ____ 3D: ____

FLOW FIELD MODELED (√):
- Laminar: ____ Turbulent: ____
- Other: Scheduled mixing.

BASIC MODELING APPROACH (√):
- Premixed: ____ Mixing: √
- Other (specify): ____

References for Approach Used: ALOS Final Report

THERMAL DRIVER MODELED (√):
- Arc Heater: ____ Combustor: ____
- Shock Tube: ____ Resistance Heater: ____
- Other: Not modeled.

F-ATOM DISSOCIATION FROM (√):
- F_2: √ SF_6: √
- Other (specify): NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: *

DILUENTS MODELED: He, N_2

MODELS EFFECTS ON MIXING RATE DUE TO (√):
- Nozzle Boundary Layers: √ Shock Waves: ____
- Prereactions (thermal blockage): ____ Turbulence: ____
- Other (specify): ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
- Media Index Variations: √
- Other (specify): ____

* Uses equilibrium thermochemistry

CODE NAME: TDWORRC*

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Performs 3-D wave optics resonator analysis of a cylindrical annular ring laser resonator in either two reflaxicon or two waxicon beam compactor assembly.

ASSESSMENT OF CAPABILITIES: General geometry specification; i.e., positive or negative branch, arbitrary scraper location, analytical gain model. Mirror misalignment, mirror misfigure, mirror thermal distortion models, struts. Ray distribution beam compactors.

ASSESSMENT OF LIMITATIONS: Half-plane symmetry. No cross-slit filter model. One V-T transition operation.

OTHER UNIQUE FEATURES: Resonator geometries modeled: unstable ring resonator with: PPTANH reflaxicon - or waxicon beam compactor, negative (spatial filter) or positive branch, self-imaging scraper geometry. 180° beam rotation at scraper.

ORIGINATOR/KEY CONTACT:

Name: Victor L. Gamiz Phone: (213) 884-3346

Organization: Rocketdyne, Laser Optics

Address: 6633 Canoga Ave., Canoga Park, California

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T) Simplified 3-D loaded cavity resonator code - Nov 1978, G-0-78-1123; (T)(U) 3-D bare cavity resonator code.

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): Detailed checkout.

Ownership?: Rocketdyne

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 176

TRANSPORTABLE?: No

Machine Dependent Restrictions: Uses extended core.

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:	<250K	100
Typical Job:	<250K	1000 CDC 176
Large Job:	<250K	2000

Approximate Number of FORTRAN Lines: 8000

*3-D Wave Optics Ring Resonator Code

CODE NAME: TDNORRC

OPTICS

BASIC TYPE (√)
Physical Optics: ✓ Geometrical: ____

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar: ✓ Vector: ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region: CY Annular Region: CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region:		✓
Annular Region:		✓

FIELD SYMMETRY RESTRICTIONS: Half-plane symmetry.

MIRROR SHAPE(S) ALLOWED (√):
Square: ____ Circular: ✓ Strip: ____
Rectangular: ____ Elliptical: ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry: ____
Fixed, Multiple Resonator Geometries: ✓
Modular, Multiple Resonator Geometries: ____

PROPAGATION TECHNIQUE (√ all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms:		✓
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT):	✓	✓
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):	✓	

Other (specify): ____

CONVERGENCE TECHNIQUE (√):
Power Comparison: ✓ Field Comparison: ____
Other: ____

ACCELERATION ALGORITHMS USED?: No
Technique: ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM: (√):
Prony: ✓
Other: ____

RESONATOR TYPE (√): Standing Wave: ____
Traveling Wave (Ring): ✓ Reverse TW: ____

BRANCH (√): Positive: ✓ Negative: ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors: ✓ Spherical Mirrors: ✓
Cylindrical Mirrors: ____ Telescopes: ✓
Scraper Mirrors: ✓

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:	✓	✓
Variable Cone Offset:	✓	✓
Other (specify): PPTANH	✓	✓

Deformable Mirrors: ✓
Spatial Filters: ✓ Gratings: ____
Other Elements: 180^0 Beam Rotator.

GAIN MODELS (√): Bare Cavity Only: ____
Simple Saturated Gain: ✓ Detailed Gain: ____

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt: ✓ Decentration: ✓
Aberrations/Thermal Distortions:
Arbitrary: ____
Selected (specify): ____
Reflectivity Loss: ✓
Output Coupler Edges: Rolled: ____
Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation: ____
Gas Absorption: ____
Overlapped Beams: ____
Other: ____

FAR-FIELD MODELS (√): Beam Steering Removal: ✓
Optimal Focal Search: ✓ Beam Quality: ✓
Other: ____

KINETICS

GAIN REGION MODELED (√): None
Compact Region: ____ Annular Region: ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region: ____ Annular Region: ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes?: ____ Flow Direction?: ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 = YX + Y$
$Y + X_2 = YX + X$

$\cancel{X}$	F	Cl	Br	I
H				
D				

Cold ($F + H_2$): ____
Hot ($H + F_2$): ____ Chain ($F + H_2$ & $H + F_2$): ____
Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference
V-T: ____
V-R: ____
V-V: ____
Other: ____

Single Line Model (√): ____
Multiline Model (√): ____
Assumed Rotational Population Distribution State (√):
Equilibrium: ____ Nonequilibrium: ____
Number of Laser Lines Modeled: ____
Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):
Doppler Broadening: ____
Collisional Broadening: ____
Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√): None
Cylindrical, Radially Flowing: ____
Rectangular, Linearly Flowing: ____
Other: ____

COORDINATE SYSTEM: ____

FLUID GRID DIMENSION (√): 1D: ____ 2D: ____ 3D: ____

FLOW FIELD MODELED (√):
Laminar: ____ Turbulent: ____
Other: ____

BASIC MODELING APPROACH (√):
Premixed: ____ Mixing: ____
Other (specify): ____
References for Approach Used: ____

THERMAL DRIVER MODELED (√):
Arc Heater: ____ Combustor: ____
Shock Tube: ____ Resistance Heater: ____
Other: ____

F-ATOM DISSOCIATION FROM (√):
F_2: ____ SF_6: ____
Other (specify): ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL?: ____

DILUENTS MODELED: ____

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers: ____ Shock Waves: ____
Prereactions (thermal blockage): ____ Turbulence: ____
Other (specify): ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations: ____
Other (specify): ____

CODE NAME: TMRO

CODE TYPE: Optics, Kinetics, and Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Version of MRO for toric resonators (TMRO).

ASSESSMENT OF CAPABILITIES: Models L=0 mode for half symmetric or confocal toric ring or standing wave resonators. Provides economical screen code for CROQ.

ASSESSMENT OF LIMITATIONS: No azimuthal variations modeled. No axicon. Provides only a mode which has the same geometric optics properties in the gain region as CROQ.

OTHER UNIQUE FEATURES: Toric resonator modeled.

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock Phone: (213) 535-3484

Organization: TRW DSSG

Address: RI/1162, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): none; however, the BLAZER and MRO codes, June 78 (TRW), contain much information; (U): none, but nearly same as MRO (use BLAZER user manual, November 78). Listings available.

STATUS:

Operational Currently?: Yes

Under Modification?: Yes

Purpose(s): For ACLOS Program, TMRO being modified for rotational nonequilibrium and anomalous dispersion description.

Ownership?: Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CYBER 174 TRW/TSS
AFWL CYBER 176, NOS/BE

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: CDC

SELF-CONTAINED?: No

Other Codes Required (name, purpose): VIINT, KBLIMP, Monte Carlo, ALFA

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	151K	400
Large Job:		

Approximate Number of FORTRAN Lines: 4500

CODE NAME: TMRO

OPTICS

BASIC TYPE (√)
- Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)
- Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
- Compact Region ___ Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region	✓	

FIELD SYMMETRY RESTRICTIONS?: L=0

MIRROR SHAPE(S) ALLOWED (√):
- Square ___ Circular ✓ Strip ___
- Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
- Fixed, Single Resonator Geometry ___
- Fixed, Multiple Resonator Geometries ✓
- Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	Compact	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature (Modified)		✓
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)		

- Other (specify) ___

CONVERGENCE TECHNIQUE (√):
- Power Comparison ✓ Field Comparison ___
- Other ___

ACCELERATION ALGORITHMS USED? No
- Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
- Prony ___
- Other ___

RESONATOR TYPE (√): Standing Wave ✓
- Traveling Wave (Ring) ✓ Reverse TW ___

BRANCH (√): Positive ✓ Negative ✓

OPTICAL ELEMENT MODELS INCLUDED (√):
- Flat Mirrors ___ Spherical Mirrors ___
- Cylindrical Mirrors ___ Telescopes ___
- Scraper Mirrors ___

Axicons	Waxicons	Reflaxicons
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

- Deformable Mirrors ___
- Spatial Filters ___ Gratings ___
- Other Elements: Toric mirrors.

GAIN MODELS (√): Bare Cavity Only ___
- Simple Saturated Gain ___ Detailed Gain ✓

BARE CAVITY FIELD MODIFIER MODELS (√):
- Mirror Tilt ___ Decentration ___
- Aberrations/Thermal Distortions:
  - Arbitrary ___
  - Selected (specify) ___
- Reflectivity Loss ✓
- Output Coupler Edges: Rolled ___
  - Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√)
- Medium Index Variation ✓
- Gas Absorption ___
- Overlapped Beams ___
- Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ___
- Optimal Focal Search ___ Beam Quality ___
- Other ___

KINETICS

GAIN REGION MODELED (√):
- Compact Region ___ Annular Region ✓

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
- Compact Region ___ Annular Region: CY

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region	✓		

GAIN REGION SYMMETRY RESTRICTIONS:
- Gain Vary Along Optic Axes? No Flow Direction?: Yes

PULSED: ___ **CW:** ✓ **KINETICS MODELED**

CHEMICAL PUMPING REACTIONS MODELED (√):

$\left\{\begin{matrix} X + Y_2 \to YX + Y \\ Y + X_2 \to YX + X \end{matrix}\right\}$

	~~X~~	F	Cl	Br	I
H		✓			
D		✓			

- Cold $(F + H_2)$ ✓
- Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___
- Other (specify) NF_3

ENERGY TRANSFER MODES MODELED (√): Reference
- V-T: ✓ BLAZER and MRO
- V-R: ___
- V-V: ✓
- Other RR with ACLOS rot. non-equlib. model.
- Single Line Model (√) ___
- Multiline Model (√) ✓
- Assumed Rotational Population Distribution State (√)
  - Equilibrium ___ Nonequilibrium ___
- Number of Laser Lines Modeled 24
- Source of Rate Coefficients Used in Code N. Cohen

LINE PROFILE MODELS (√):
- Doppler Broadening ✓
- Collisional Broadening ✓
- Other (specify) Operation at line center.

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) **(√):**
- Cylindrical, Radially Flowing ✓
- Rectangular, Linearly Flowing ___
- Other ___

COORDINATE SYSTEM: CY

FLUID GRID DIMENSION (√): 1D ✓ 2D ___ 3D ___

FLOW FIELD MODELED (√):
- Laminar ___ Turbulent ___
- Other Scheduled mixing.

BASIC MODELING APPROACH (√):
- Premixed ___ Mixing ___
- Other (specify) Scheduled mixing.
- References for Approach Used BLAZER and MRO.

THERMAL DRIVER MODELED (√):
- Arc Heater ___ Combustor ✓
- Shock Tube ___ Resistance Heater ___
- Other ___

F-ATOM DISSOCIATION FROM (√)
- F_2 ✓ SF_6 ___
- Other (specify) NF_3

F-ATOM CONCENTRATION DETERMINED FROM MODEL? Yes*

DILUENTS MODELED He, N_2, CF_4

MODELS EFFECTS ON MIXING RATE DUE TO (√)
- Nozzle Boundary Layers ___ Shock Waves ___
- Prereactions (thermal blockage) ___ Turbulence ___
- Other (specify) Scheduled three stream; fuel, oxidant, mixed.

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
- Media Index Variations ✓
- Other (specify) ___

* in the mixed stream

CODE NAME: TWODNOZ

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculate nozzle flow including boundary layer and inviscid core analysis.

ASSESSMENT OF CAPABILITIES: Can calculate two dimensional or axisymmetric nozzle flow. Uses local similarity boundary layer solution coupled with inviscid core solution.

ASSESSMENT OF LIMITATIONS: Does not calculate boundary layer profiles as presently formulated.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: D. Haflinger/P. Lohn Phone: (213) 536-1624

Organization: TRW DSSG

Address: RI/1038, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): None.

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: TRW

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	40K	10
Large Job:		

Approximate Number of FORTRAN Lines: 1000

CODE NAME: TWODNOZ

OPTICS

BASIC TYPE (√): None

Physical Optics ____ Geometrical ____

FIELD (POLARIZATION) REPRESENTATION (√):

Scalar ____ Vector ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):

Compact Region ____ Annular Region ____

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS?: ____

MIRROR SHAPE(S) ALLOWED (√):

Square: ____ Circular: ____ Strip: ____

Rectangular ____ Elliptical ____ Arbitrary: ____

CONFIGURATION FLEXIBILITY (√):

Fixed, Single Resonator Geometry: ____

Fixed, Multiple Resonator Geometries: ____

Modular, Multiple Resonator Geometries: ____

PROPAGATION TECHNIQUE (√all that apply):

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature:		
Fast Fourier Transform (FFT):		
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ____

CONVERGENCE TECHNIQUE (√):

Power Comparison: ____ Field Comparison: ____

Other: ____

ACCELERATION ALGORITHMS USED?: ____

Technique: ____

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):

Prony: ____

Other: ____

None

RESONATOR TYPE (√): Standing Wave: ____

Traveling Wave (Ring): ____ Reverse TW ____

BRANCH (√): Positive: ____ Negative: ____

OPTICAL ELEMENT MODELS INCLUDED (√):

Flat Mirrors: ____ Spherical Mirrors: ____

Cylindrical Mirrors: ____ Telescopes: ____

Scraper Mirrors: ____

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
Variable Cone Offset:		
Other (specify):		

Deformable Mirrors: ____

Spatial Filters: ____ Gratings: ____

Other Elements: ____

GAIN MODELS (√): Bare Cavity Only: ____

Simple Saturated Gain: ____ Detailed Gain: ____

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt: ____ Decentration: ____

Aberrations/Thermal Distortions:

Arbitrary: ____

Selected (specify): ____

Reflectivity Loss: ____

Output Coupler Edges: Rolled: ____

Serrated: ____ Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (√):

Medium Index Variation: ____

Gas Absorption: ____

Overlapped Beams: ____

Other ____

FAR-FIELD MODELS (√): Beam Steering Removal ____

Optimal Focal Search: ____ Beam Quality: ____

Other ____

KINETICS

GAIN REGION MODELED (√): None

Compact Region: ____ Annular Region: ____

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region: ____ Annular Region: ____

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optic Axes?: ____ Flow Direction?: ____

PULSED: ____ CW: ____ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):

$$\left\{\begin{array}{l} X + Y_2 = YX + Y \\ Y + X_2 = YX + X \end{array}\right\}$$

X \ Y	F	Cl	Br	I
H				
D				

Cold (F + H_2): ____

Hot (H + F_2): ____ Chain (F + H_2 & H + F_2): ____

Other (specify): ____

ENERGY TRANSFER MODES MODELED (√): Reference

V-T: ____

V-R: ____

V-V: ____

Other: ____

Single Line Model (√): ____

Multiline Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____ Nonequilibrium: ____

Number of Laser Lines Modeled: ____

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening ____

Collisional Broadening ____

Other (specify): ____

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√):

Cylindrical, Radially Flowing: √

Rectangular, Linearly Flowing: √

Other: ____

COORDINATE SYSTEM: Cart/axisymmetric

FLUID GRID DIMENSION (√): 1D: ____ 2D: √ 3D ____

FLOW FIELD MODELED (√):

Laminar: √ Turbulent: ____

Other: ____

BASIC MODELING APPROACH (√):

Premixed: √ Mixing: ____

Other (specify): ____

References for Approach Used: ____

THERMAL DRIVER MODELED (√):

Arc Heater: ____ Combustor: ____

Shock Tube: ____ Resistance Heater: ____

Other: ____

F-ATOM DISSOCIATION FROM (√):

F_2: ____ SF_6 ____

Other (specify): ____

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ____

DILUENTS MODELED: ____

MODELS EFFECTS ON MIXING RATE DUE TO (√):

Nozzle Boundary Layers ____ Shock Waves ____

Prereactions (thermal blockage) ____ Turbulence ____

Other (specify): ____

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):

Media Index Variations ____

Other (specify): ____

CODE NAME: URINLA2

CODE TYPE: Optics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models cylindrical lasers with arbitrary axicon (except noneverting waxicon). Bare resonator code which determines mode control and beam quality.

Unstable Resonator with Internal Non-Linear Axicon (URINLA2).

ASSESSMENT OF CAPABILITIES: Computationally accurate, uses full OPD matrix treatment of axicon, very flexible for design.

ASSESSMENT OF LIMITATIONS: Computationally slow, number of Gaussian points and Fourier components limited by large core storage capability on CYBER 176. Half plane symmetry required for misalignments, i.e., all decentrations colinear, all tilt axes parallel, and at 90° from decentration direction.

OTHER UNIQUE FEATURES: Resonators modeled: HSURIA, "HSURIA" with toric back mirror, or TURIA. Models H-H and H-P reflaxicons and waxicons, P-P reflaxicons, tip unloaded axicons, and variable magnification axicons.

ORIGINATOR/KEY CONTACT:

Name: Donald L. Bullock
Phone: (213) 535-4384
Organization: TRW DSSG
Address: R1/1162, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): Annular Laser Mode Studies Final Report; (U): Program URINLA2 User Manual, June 1978; Listings available.

STATUS:

Operational Currently?: Yes
Under Modification?: No
Purpose(s):

Ownership?: Government
Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): AFWL CYBER 176, NOS/BE

TRANSPORTABLE?: With modification
Machine Dependent Restrictions: CDC only

SELF-CONTAINED?:
Other Codes Required (name, purpose): Yes

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:	136K (SCM), 100K (LCM)	1800
Large Job:		

Approximate Number of FORTRAN Lines: 2000

CODE NAME: URINLA2

OPTICS

BASIC TYPE (√)
Physical Optics ✓ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):
Scalar ✓ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):
Compact Region CY Annular Region CY

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region	✓	✓
Annular Region	✓	✓

FIELD SYMMETRY RESTRICTIONS? Half-plane.

MIRROR SHAPE(S) ALLOWED (√):
Square ___ Circular ✓ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ✓
Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature	✓	✓
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√):
Power Comparison ___ Field Comparison ✓
Other ___

ACCELERATION ALGORITHMS USED? Yes
Technique Aitken*

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other Aitken

*(Cf. The Algebraic Eigenvalue Problem, J. H. Wilkinson, Oxford (1965), p. 578).

RESONATOR TYPE (√) Standing Wave ✓
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√): Positive ✓ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√):
Flat Mirrors ___ Spherical Mirrors ___
Cylindrical Mirrors ___ Telescopes ✓
Scraper Mirrors ✓

Axicons	Waxicons	Reflaxicons
Arbitrary	✓	✓
Linear	✓	✓
Parabola-Parabola		✓
Variable Cone Offset	✓	✓
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements H-H & H-P reflaxicons and waxicons; P-P reflaxicons, rear cone or flat

GAIN MODELS (√): Bare Cavity Only ✓
Simple Saturated Gain ___ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ✓ Decentration ✓
Aberrations/Thermal Distortions:
Arbitrary ___
Selected (specify) Aberrations only.
Reflectivity Loss ___
Output Coupler Edges Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ✓
Optimal Focal Search ✓ Beam Quality ✓
Other ___

KINETICS

GAIN REGION MODELED (√): None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ CW: ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):
$X + Y_2 \to YX + Y$
$Y + X_2 \to YX + X$

	F	Cl	Br	I
H				
D				

Cold ($F + H_2$) ___
Hot ($H + F_2$) ___ Chain ($F + H_2$ & $H + F_2$) ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√): Reference
V-T ___
V-R ___
V-V ___
Other ___
Single Line Model (√) ___
Multiline Model (√) ___
Assumed Rotational Population Distribution State (√):
Equilibrium ___ Nonequilibrium ___
Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√):
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√) None
Cylindrical, Radially Flowing ___
Rectangular, Linearly Flowing ___
Other ___

COORDINATE SYSTEM ___
FLUID GRID DIMENSION (√): 1D ___ 2D ___ 3D ___
FLOW FIELD MODELED (√):
Laminar ___ Turbulent ___
Other ___

BASIC MODELING APPROACH (√):
Premixed ___ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√):
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√):
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___
DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):
Nozzle Boundary Layers ___ Shock Waves ___
Prereactions (thermal blockage) ___ Turbulence ___
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):
Media Index Variations ___
Other (specify) ___

CODE NAME VIINT

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Calculates flow between wedges for hypersonic wedge modeling.

(Viscid Inviscid Interaction Program (VIINT))

ASSESSMENT OF CAPABILITIES: Calculates full viscous-inviscid flow field with shocks, reflected shocks, and shock-body interactions. Considers transverse pressure gradients in the supersonic flow.

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: J. Ohrenberger **Phone:** (213) 536-4024

Organization: TRW DSSG

Address: 88/1012, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): "Turbulent Near Wake Modeling Analysis for Reentry Application", J.T. Ohrenberger, Prepared for Ballistic Missile Defense Adv. Tech. Center, DASG60-76-C-0043, April 1977; (U): "Computer Program Description and Users Manual of a Near and Far Wake Modeling Analysis for Reentry under Laminar or Turbulent Boundary Layer Conditions," J.T. Ohrenberger, Prep. for Ballistic Missile Defense Systems Command, DASG60-76-C-0043, March 1979. Ohrenberger, J.T. and Baum, E., "A Theoretical Model of the Near Wake of a Slender Body in Supersonic Flow,", AIAA Journal Vol. 10, No. 9, September 1972, pp. 1165-1172. AIAA Paper No., 70-792 (June 1970). AIAA Paper No., 72-116 (Jan., 1972)

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: TRW

Proprietary?: On file at ARC Facility, BMDATC, Huntsville

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600/7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	65K	60
Large Job:		

Approximate Number of FORTRAN Lines: 3500

CODE NAME: VIINT

OPTICS

BASIC TYPE (√) None
Physical Optics ___ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√)
Scalar ___ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√)

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ___

MIRROR SHAPE(S) ALLOWED (√)
Square ___ Circular ___ Strip ___
Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√)
Fixed, Single Resonator Geometry ___
Fixed, Multiple Resonator Geometries ___
Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	COMPACT	ANNULAR
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener-Fresnel-Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√):
Power Comparison ___ Field Comparison ___
Other ___

ACCELERATION ALGORITHMS USED? ___
Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):
Prony ___
Other ___

None

RESONATOR TYPE (√) Standing Wave ___
Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√) Positive ___ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√)
Flat Mirrors ___ Spherical Mirrors ___
Cylindrical Mirrors ___ Telescopes ___
Scraper Mirrors ___

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ___
Spatial Filters ___ Gratings ___
Other Elements ___

GAIN MODELS (√): Bare Cavity Only ___
Simple Saturated Gain ___ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√):
Mirror Tilt ___ Decentration ___
Aberrations/Thermal Distortions
Arbitrary ___
Selected (specify) ___
Reflectivity Loss ___
Output Coupler Edges: Rolled ___
Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):
Medium Index Variation ___
Gas Absorption ___
Overlapped Beams ___
Other ___

FAR-FIELD MODELS (√) Beam Steering Removal ___
Optimal Focal Search ___ Beam Quality ___
Other ___

KINETICS

GAIN REGION MODELED (√) None
Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)
Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√)

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS
Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED ___ CW ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√)

$\left\{ \begin{matrix} X + Y_2 & YX + Y \\ Y + X_2 & YX + X \end{matrix} \right\}$

X/Y	F	Cl	Br	I
H				
D				

Cold $(F + H_2)$ ___
Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___
Other (specify) ___

ENERGY TRANSFER MODES MODELED (√) Reference
V-T ___
V-R ___
V-V ___
Other ___

Single Line Model (√) ___
Multiline Model (√) ___

Assumed Rotational Population Distribution State (√)
Equilibrium ___ Nonequilibrium ___

Number of Laser Lines Modeled ___
Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)
Doppler Broadening ___
Collisional Broadening ___
Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√)
Cylindrical, Radially Flowing √
Rectangular, Linearly Flowing √
Other ___

COORDINATE SYSTEM Cart. and cylind.

FLUID GRID DIMENSION (√) 1D ___ 2D √ 3D ___

FLOW FIELD MODELED (√)
Laminar √ Turbulent ___
Other Turb capability available.

BASIC MODELING APPROACH (√)
Premixed √ Mixing ___
Other (specify) ___
References for Approach Used ___

THERMAL DRIVER MODELED (√)
Arc Heater ___ Combustor ___
Shock Tube ___ Resistance Heater ___
Other ___

F-ATOM DISSOCIATION FROM (√)
F_2 ___ SF_6 ___
Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? No

DILUENTS MODELED: ___

MODELS EFFECTS ON MIXING RATE DUE TO (√)
Nozzle Boundary Layers √ Shock Waves √
Prereactions (thermal blockage) ___ Turbulence √
Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√)
Media Index Variations √
Other (specify) ___

CODE NAME: WAP*

CODE TYPE: Gasdynamics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To determine base flow between laser nozzle. Detailed analysis of base flows, recirculation and embedded subsonic zone, boundary remnant lip and wake shock formation are included.

ASSESSMENT OF CAPABILITIES: Analysis extendable through saddle to the intermediate near wake. Heat release capability to simulate exothermic reactions. Parabolized Navier-Stokes (finite difference) calculation. Base pressure determined uniquely by saddle point technique.

ASSESSMENT OF LIMITATIONS: Does not handle chemistry directly. Two dimensional (but can handle source flows).

OTHER UNIQUE FEATURES: Can handle base injection.

ORIGINATOR/KEY CONTACT:

Name: J. Ohrenberger **Phone:** (213) 536-4024

Organization: TRW DSSG

Address: 88/1012, One Space Park, Redondo Beach, California 90278

AVAILABLE DOCUMENTATION: (T = Theory, U = User, RP = Relevant Publication): (T): "Turbulent Near Wake Modeling Analysis for Reentry Application," J.T. Ohrenberger, Prep for Ballistic Missile Defense Adv. Tech. Center. DASG60-76-C-0043, April 1977; (U): "Computer Program Description and Users Manual of a Near and Far Wake Modeling Analysis for Reentry under Laminar or Turbulent Boundary Layer Conditions." J.T. Ohrenberger, Prep for Ballistic Missile Defense Systems Command, DASG60-76-C-0043, March 1979. Ohrenberger, J.T. and Baum, E., "A Theoretical Model of the Near-Wake of a Slender Body in Supersonic Flow," AIAA Journal, Vol. 10, No. 9, September 1972, pp. 1165-1172. AIAA paper No. 70-792 (June 1970). AIAA paper 72-116 (Jan 1972)

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: TRW

Proprietary?: On file at ARC Facility, BMDATC, Huntsville

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec. CDC 7600)
Small Job:		
Typical Job:	107K	300
Large Job:		

Approximate Number of FORTRAN Lines: 7000

* Wake Analysis Program

CODE NAME: WAP

OPTICS

BASIC TYPE (√): None

Physical Optics ___ Geometrical ___

FIELD (POLARIZATION) REPRESENTATION (√):

Scalar ___ Vector ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ___ Annular Region ___

TRANSVERSE GRID DIMENSIONALITY (√):

	1D	2D
Compact Region		
Annular Region		

FIELD SYMMETRY RESTRICTIONS? ___

MIRROR SHAPE(S) ALLOWED (√):

Square ___ Circular ___ Strip ___

Rectangular ___ Elliptical ___ Arbitrary ___

CONFIGURATION FLEXIBILITY (√):

Fixed, Single Resonator Geometry ___

Fixed, Multiple Resonator Geometries ___

Modular, Multiple Resonator Geometries ___

PROPAGATION TECHNIQUE

	[illegible]	Annular
Fresnel Integral Algorithms		
With Kernel Averaging		
Gaussian Quadrature		
Fast Fourier Transform (FFT)		
Fast Hankel Transform (FHT)		
Gardener Fresnel-Kirchhoff (GFK)		

Other (specify) ___

CONVERGENCE TECHNIQUE (√):

Power Comparison ___ Field Comparison ___

Other ___

ACCELERATION ALGORITHMS USED? ___

Technique ___

MULTIPLE EIGENVALUE/VECTOR EXTRACTION ALGORITHM (√):

Prony ___

Other ___

RESONATOR TYPE (√): None

Standing Wave ___

Traveling Wave (Ring) ___ Reverse TW ___

BRANCH (√): Positive ___ Negative ___

OPTICAL ELEMENT MODELS INCLUDED (√):

Flat Mirrors ___ Spherical Mirrors ___

Cylindrical Mirrors ___ Telescopes ___

Scraper Mirrors ___

	Waxicons	Reflaxicons
Axicons		
Arbitrary		
Linear		
Parabola-Parabola		
Variable Cone Offset		
Other (specify)		

Deformable Mirrors ___

Spatial Filters ___ Gratings ___

Other Elements ___

GAIN MODELS (√): Bare Cavity Only ___

Simple Saturated Gain ___ Detailed Gain ___

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt ___ Decentration ___

Aberrations/Thermal Distortions

Arbitrary ___

Selected (specify) ___

Reflectivity Loss ___

Output Coupler Edges: Rolled ___

Serrated ___ Other ___

LOADED CAVITY FIELD MODIFIER MODELS (√):

Medium Index Variation ___

Gas Absorption ___

Overlapped Beams ___

Other ___

FAR-FIELD MODELS (√): Beam Steering Removal ___

Optimal Focal Search ___ Beam Quality ___

Other ___

KINETICS

GAIN REGION MODELED (√): None

Compact Region ___ Annular Region ___

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region ___ Annular Region ___

KINETICS GRID DIMENSIONALITY (√):

	1D	2D	3D
Compact Region			
Annular Region			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optic Axes? ___ Flow Direction? ___

PULSED: ___ CW: ___ KINETICS MODELED

CHEMICAL PUMPING REACTIONS MODELED (√):

$X + Y_2 \rightarrow YX + Y$

$Y + X_2 \rightarrow YX + X$

	X	F	Cl	Br	I
Y	✓				
H					
D					

Cold $(F + H_2)$ ___

Hot $(H + F_2)$ ___ Chain $(F + H_2$ & $H + F_2)$ ___

Other (specify) ___

ENERGY TRANSFER MODES MODELED (√): Reference

V-T ___

V-R ___

V-V ___

Other ___

Single Line Model (√) ___

Multiline Model (√) ___

Assumed Rotational Population Distribution State (√)

Equilibrium ___ Nonequilibrium ___

Number of Laser Lines Modeled ___

Source of Rate Coefficients Used in Code ___

LINE PROFILE MODELS (√)

Doppler Broadening ___

Collisional Broadening ___

Other (specify) ___

GAS DYNAMICS

NOZZLE GEOMETRY MODELED (and type) (√):

Cylindrical, Radially Flowing ✓

Rectangular, Linearly Flowing ✓

Other ___

COORDINATE SYSTEM: Cartesian

FLUID GRID DIMENSION (√): 1D ___ 2D ✓ 3D ___

FLOW FIELD MODELED (√):

Laminar ✓ Turbulent ✓

Other ___

BASIC MODELING APPROACH (√):

Premixed ✓ Mixing ___

Other (specify) ___

References for Approach Used ___

THERMAL DRIVER MODELED (√):

Arc Heater ___ Combustor ___

Shock Tube ___ Resistance Heater ___

Other ___

F-ATOM DISSOCIATION FROM (√):

F_2 ___ SF_6 ___

Other (specify) ___

F-ATOM CONCENTRATION DETERMINED FROM MODEL? ___

DILUENTS MODELED ___

MODELS EFFECTS ON MIXING RATE DUE TO (√):

Nozzle Boundary Layers ✓ Shock Waves ✓

Prereactions (thermal blockage) ___ Turbulence ✓

Other (specify) ___

MODELS EFFECTS ON OPTICAL MODES DUE TO (√):

Media Index Variations ✓

Other (specify) ___

Section IV

SUPPLEMENTARY INFORMATION FOR LONG SURVEY FORM

INTRODUCTION

The first two columns in the long survey form relate to the capability of the code to perform optical modeling of the elctromagnetic fields in the laser cavity. The third column summarizes the key features of the gain region chemical kinetic processes available in the code. The last column deals with the gasdynamic properties treated by the code.

This section provides supplementary background information keyed to the survey form format and ordering of topics. This brief narrative provides introductory material to the user of this survey who may not be conversant with some portions of this broad, complex physical, chemical, and computational problem. Some or all of the material will be well known to the reader. Where it is not, we do not claim to provide an in-depth, self-contained description of phenomena but, rather, a brief highlighting of the topics so that the reader can get an immediate impression of the nature of the material and the degree of completeness of its treatment by the codes.

We must, furthermore, warn the reader that the individual codes treat a number of these phenomena very differently, so the general description given here may vary from the approach in a particular code.

In short, those readers who require special, in-depth knowledge of any particular topic treated here should seek that level of information from the key contact person denoted on the first page of the long form or from the references given.

OPTICS (COLUMN 1)

Basic Type

Codes generally fall into two categories: (a) those that use *geometrical* ray tracing techniques either to get usually quick, zero*th* order analyses or evaluations of optical resonator performance or to evaluate optical component specifications in systems such as telescopes beam transfer, etc. An example would be a misalignment sensitivity study or the generation of OPD (optical path differences) for input to a physical optics code; (b) *physical* optics codes that calculate propagation by nearly exact algorithms can predict resonator modes and can account for physical optics phenomena such as diffraction and dispersion.

Field (Polarization) Representation

The electromagnetic field is fundamentally a vector field.* In the general case, any valid resonator analysis must accommodate to the vector character of the electromagnetic field. Nevertheless, to simplify the treatment of these complex problems, we are highly motivated to find special cases where a scalar or single vector component treatment is valid.

In the case of an empty resonator, the scalar treatment is valid when a single component of the electromagnetic vector field can propagate through the entire resonator and back to the starting point without any coupling to other components of the field.

As an example, consider the reflection of light incident along the axis of a conical reflector. The field configurations that do not mix are those whose transverse polarization is everywhere either parallel with or perpendicular to the plane of incidence locally. If some other field configuration is incident, such as plane-polarized light, mixing will occur and an orthogonal polarization will result.

Thus, the inclusion of conical elements inside the resonator that scramble the field-polarization vector has led to the development of more detailed codes that keep track of the polarization vector at each field point. These vector codes divide the polarization into two components and combine or resolve the components as necessary at the end of each propagation leg.

The case of a loaded resonator introduces additional complications. In an empty resonator where a scalar treatment is valid, the scalar treatment of modes with orthogonal polarizations may proceed independently. In a loaded resonator, the polarization may couple through such effects as saturation differences of the gain medium and mirror distortion, since only one polarization component may be absorbing. Thus for a scalar treatment to be valid in the loaded resonator, we must suppress all but the desired polarization mode.

Finally, Maxwell's equations predict a depolarization term given by

$$\mathbf{E} \cdot \nabla \ln n^2$$

where E is the electric field and n is the complex index of refraction. For media in which gradients in index are negligible in a wavelength, the latter term can be neglected compared with terms retained in the Helmholtz equation, i.e., the term

$$n^2 k^2 \mathbf{E},$$

where k is the wave number.

For most media of interest in the high-energy chemical laser problem, this condition is well satisfied.

*One might even argue that because of the peculiar properties of the cross product, the electromagnetic field is actually a second-rank tensor field.

Coordinate System

The numerical algorithms for beam propagation are simpler, usually more efficient, and possibly more accurate when the coordinate system (or system of grid points where the field is specified) matches the resonator geometry. In chemical laser resonators two types of beams are typically encountered, compact beams and annular beams (Fig. IV-1). Circular compact beams and annular beams are best described by use of a cylindrical coordinate system, and beams of square and rectangular cross section typically should use Cartesian coordinates. The particular curvature of a wavefront (spherical, cylindrical, planar, etc.) usually does not influence the choice of coordinate system. One reason for this is because most numerical propagation algorithms are simplified by propagating planar wavefront beams. In this case the appropriate curvature corresponding to a given optical element is formulated as a phase sheet* which then multiplies the field. The more general codes offer the user a choice of coordinate systems for describing compact region fields that are selected according to the geometry of the elements to be modeled. Cartesian coordinates are usually not considered appropriate for representing annular beams because of the large number of grid points that would be typically involved in modeling cases of interest. In fact, usually a restriction is even forced on the general use of cylindrical coordinates, which leads to the use of so-called strip algorithms for propagating annular beams. (The strip propagator is elaborated upon in later discussions on specific propagators.)

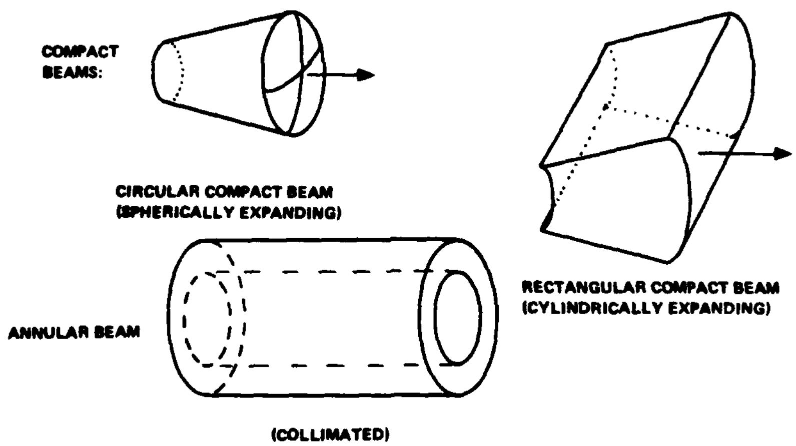


Fig. IV-1 — Types of beams

Transverse Grid Dimensionality

Many times, codes are developed based on tradeoffs between numerical accuracy, code capability, and computer run time. The simplest codes are one-dimensional (1-D) and are relatively fast, running at the expense of the ability of model asymmetric phenomena such

*Assuming, as is usually the case, that the curvature is sufficiently small that amplitude differences over the range of OPDs can be ignored.

as misalignments.* One-dimensional codes can be used to provide reasonable approximations for laser power, spectral content, mode shapes and separation, mirror flux loads, axisymmetric thermal distortions (such as thermal bowing), and misalignments in the flow direction for short gain lengths. Two-dimensional (2-D) codes more accurately model more complex phenomena such as misalignments, two-dimensional asymmetry of the media, arbitrary mirror distortions, and strut obscurations; thus, 2-D codes offer the capability of performing a number of important sensitivity studies encountered in practical resonators that cannot be handled with the 1-D codes.

The dimensionality selected is related to the highest expected spatial frequency structure developed in the electromagnetic field due to diffraction, gain medium inhomogeneities, flow properties, etc. Typical upper limits dictated by computer machine capabilities for current (1980) state-of-the-art machines are listed below.

	Dimensionality	Fresnel Number
1-D problem	$2^{10} - 2^{11}$	$100 - 500$
2-D problem	$2^8 \times 2^8$	$20 - 40$

The implications of machine restrictions on array sizes can be appreciated by a simple example. Suppose the required sampling leads to a grid of 128 × 128 points. This leads to a basic array of over 16,000 points, and at each point we have both the real part and the imaginary part of the complex field amplitude. If we wish to store only the field amplitude and phase in a source plane and an observation plane, we require a total of 64 K_{10} storage locations even before we have loaded the computer program.

We can easily get a rough estimate of the number of grid points required in an observation plane from the following considerations. Let us imagine an infinite-slit aperture with transverse dimension $2a$ and an observation plane located a distance R downstream.

The single-slit diffraction pattern has half-cycle nulls a distance d apart in the observation plane, where d is given by

$$d = \frac{\lambda R}{2a}.$$

This distance can also be written in terms of the Fresnel number of the source as seen from the observation plane; we obtain

$$d = \frac{a}{2N_F}.$$

*This does not necessarily imply that they are more efficient.

For good sampling, we require about four points per half-cycle at the highest spatial frequency so that the spacing of points required is just $d/4$. If the characteristic transverse dimension on the observation plane is also of order $2a$, we find that the total number of points required in one transverse dimension is given by

$$m = \frac{2a}{d/4} = 16N_{\mathrm{F}} \; .$$

Thus for a Fresnel number of 50, we may require as many as 800 points in the transverse dimension. Of course this requirement may be eased if the amplitude at the source aperture falls to zero as one approaches the edge of the source grid.

In addition, when doing a detailed kinetics and gasdynamic calculation as well (see below) these arrays of field quantities must be retained at sequential times or transverse points for use in the calculation of gain as the molecules flow away from the nozzle exit plane.

When a machine core is exhausted, techniques are devised to extend the effective storage by overlay and mass storage (disk) usage. With the advent of vector, parallel processing machines of effectively unlimited core, many of these restrictions will be removed and only cost will dictate the limits of the size of problems to be attempted.

Field Symmetry Restrictions

In some instances, quasi-two-dimensional codes are assembled that assume field symmetry about a line or point. Codes also can be tailored to model systems that are circularly symmetric. These codes have definite field symmetry restrictions. Often, code users take advantage of field symmetry by specifying only the nonrepeating portion of the field. Thus one can reduce the total number of required grid points by a factor of n where there is n-fold symmetry, without affecting the field resolution.

Mirror Shapes Allowed

Codes that have been assembled with one type of coordinate system are usually restricted in their ability to model mirror shapes fitting another coordinate system. Two-dimensional Cartesian codes do an excellent job in modeling square or rectangular mirrors, and an inefficient job in modeling elliptical or circular shapes. One-dimensional Cartesian codes can model strip mirrors (mirrors that are considered infinitely long in one dimension). Elliptical mirrors that are circular or of moderate eccentricity can be handled by cylindrical coordinate codes.

The field modification by a mirror usually takes the form of an amplitude and phase change imposed on the field at the mirror plane. This introduces the effects of mirror curvature and absorption. Actual measured data on mirror shape, curvature, and reflectivity can be used as well, if available, provided that the code has been designed to accept such data.

Flexibility of Configuration

There appear to be only three approaches or philosophies taken in building detailed resonator codes. These are: (a) codes developed to model only one specific resonator type (e.g., the HSURIA*), (b) codes that allow the user to select one of several different preprogrammed resonator models usually by simply setting certain flags in the input files, and (c) codes that attempt to provide the user complete freedom to model any resonator he chooses (the modular codes). In the latter approach, the code builder attempts to provide, in a useful format, all necessary submodels that could be of interest in modeling resonators over as wide a range as possible and leaves to the code user the task of representing his own resonator by utilizing modules in the proper sequence. Essentially, the user writes his own executive program, which amounts to a particular sequence of calls to the various modules (subroutines models) representing a complete set of operations on the field in transversing one round trip through the resonator.

There are obvious advantages and disadvantages to a given approach. The fixed, single resonator code is of little use unless it models the resonator of interest. On the other hand, its limited scope offers the possibility of making it highly efficient and cost effective to run. Also, compared to the other code configurations, it *should* be the easiest to use given that all these code types are performing the same level of analysis. The fixed, multiple resonator code configuration offers the capability of modeling several different resonators with relative ease. Using one basic code to model several different resonators for performance comparisons is advantageous since the numerical precisions will be nearly the same. Such code configurations require a more complex logical structure; they can become unwieldy if too many resonator models are included. Finally, the multiple, modular code construction approach offers very great modeling flexibility in return for a great amount of foresight in the selection and interfacing of a large number of physical models on the part of the code builder, as well as the time required to construct the iteration loop to represent a particular resonator on the part of the user. The advantage is that a user will (in principle) have to learn how to use only one code. Disadvantages are that it is extremely difficult to predict all the necessary code features and build a code that is both simple and efficient to use.

Often, cost and/or schedule constraints have dictated the approach to code construction. Single-purpose codes can be built in several months by those already familiar with the physical models and the numerical algorithms. Modular codes, on the other hand, require many man-years of planning and construction before they can be used.

Propagation Technique

We turn now to the question of calculating the electromagnetic field at a downstream location when its amplitude and phase are specified on some surface upstream. The surface need not be planar, but it is often so chosen to simplify the calculations.

There are two basic propagator types, the integral type using the Huygens-Fresnel principle and the differential equation type derived from the paraxial wave equation. Each type can deal with a complete vector field, but to simplify our discussion we assume that the problem has been structured so that a scalar treatment is valid. Our discussion here is oriented toward numerical calculations. Later we will touch briefly on analytical treatments.

*Half-symmetric unstable resonator with internal axicon.

Paraxial Wave Equation

In the scalar version of paraxial wave treatment we assume that a single transverse component propagating in the z-direction can be written as the real part of the expression

$$E_x(x,y,z,t) = \Psi(x,y,z) \exp(ikz - i\omega t) ,$$

where Ψ satisfies the paraxial wave equation

$$\nabla_T^2 \Psi + 2ik \frac{d\Psi}{dz} + k^2 \left[\frac{n^2(x,y,z,t)}{n_o^2} - 1 \right] \Psi = 0 . \tag{1}$$

The refractive index may be complex if it is to include gain. If the gain is to be introduced as one or several isolated gain sheets, we set $n = n_o$ and the last term in Eq. (1) drops out.

Huygens-Fresnel or Integral Equation [1]

In the paraxial approximation, the field at any observation point downstream is given by

$$\Psi(P) = -\frac{ik}{2\pi} \int_{s_1} \frac{\Psi(s_1) \exp(ikR)}{R} \, ds_1 , \tag{2}$$

where the integral extends over the area of the source aperture s_1, R is the distance from each element in s_1 to the observation point P, and $\Psi(s_1)$ is the complex field as a function of position in the source plane.

Comparison of the Two Approaches

Since the integral equation and the paraxial wave equation are alternative approaches to the same problem, we expect that both approaches will yield the same correct answer. The question for discussion, then, is which approach can be more readily implemented in a given case.

In comparing the two approaches, we find that the integral propagator seems to be the natural choice for a long propagation distance. The integral is evaluated in a single step from the source plane to the observation plane. The numerical integration of the differential equation, on the other hand, is expected to require many steps for a long propagation distance.

As the propagation distance decreases, the quantity $\exp(ikR)$ in Eq. (2) will begin to oscillate more rapidly as we move across the aperture carrying out the numerical integration. The number of one-half cycles of oscillations is given by the Fresnel number N_F, defined by

$$N_F = a^2/(R\lambda)\,, \tag{3}$$

where a is the radius of the source aperture, λ is the wavelength, and R is as before. For good accuracy in our numerical integration, we may require somewhere between four and eight points per Fresnel number; thus, as the distance to an observation point R decreases, the Fresnel number increases to a value of, say $N_F = 100$; we require between 400 and 800 radial grid points. If, in addition we introduce tilt or otherwise destroy the axial symmetry, the total number of grid points can climb rapidly into the range of 10^3 to 10^4. This discussion assumes, of course, that the phase and amplitude of $\Psi(s_1)$ vary at a slower rate than $\exp(ikR)$, a condition not always met in practice. For relatively short distances and corresponding large values of N_F, the paraxial wave equation seems the natural choice. In the limit of short distances we have the geometric optics solution in which the electric field can be expressed in terms of the second derivatives (or equivalently, the radius of curvature of the phase fronts) of $\Psi(s_1)$ in the source plane.

In numerical calculations, the values for the electromagnetic field are always presented on a grid of finely spaced points. The configurations of the grids and the total number of points are important issues. One is always faced with the tradeoff between computer storage requirements and calculation speed on the one hand and accuracy requirements on the other.

The early calculations were often carried out with Cartesian coordinate and square or rectangular grid systems. The early fast Fourier transform (FFT) (to be discussed later) algorithms were easily applied to these systems. For circularly symmetric systems, however, this is not an efficient grid system. Accordingly, radial systems were introduced and suitable integral propagators were developed for azimuthally decomposed fields. For an axisymmetric system, the number of grid points for a given level of sampling can be reduced substantially. Even when the axial symmetry is disturbed by such factors as tilts, mirror distortions, and struts, one often samples relatively heavily in r and relatively thinly in θ, with an overall increase in sampling efficiency compared to a Cartesian system.

Before we leave our discussion of basic considerations, we mention briefly some of the analytic techniques and contrast them with the numerical techniques.

Since the early work of Horowitz [2] on the empty cavity modes of the perfectly aligned infinite strip resonator, slow and steady progress has been made with the analytic techniques. Butts and Avizonis [3] have studied the cylindrically symmetric bare resonator. Ellenwood and Meyer [4] have obtained preliminary results on the empty perfect HSURIA resonator. The analytic studies are significantly limited by the fact that they cannot deal with the general cases of major interest. Nevertheless, to the degree that they can handle important ideal cases, they serve a useful role for baseline comparison purposes. Some workers also feel that they retain closer contact with the basic physics of the problem.

Although the large numerical codes are held in mixed regard within the community, they do appear to hold promise for accurate numerical results for all cases of interest. The full set of cases of interest spans a much wider range of phenomena than those that can be handled by the analytic approaches.

The large codes may be plagued with long run times, considerable expense, and uncertain results, particularly for those cases where there is no convergence. We do not yet seem to have achieved the happy circumstance of efficient and economic computer codes producing results of high confidence for all the realistic cases of interest.

Some Specific Propagators

We present now a brief discussion of some of the features of several propagators used in practice. We will discuss only Huygens-Fresnel algorithms, since these are the most often used. The ordering here follows that of the survey form.

Kernel Averaging

This technique takes account of the fact that a relatively fine grid is required to sample rapid variations in the quantity $\exp(ikR)$ in Eq. (2), whereas a coarser grid is generally adequate for the field distribution in the source aperture. The $\exp(ikR)$ grid can be computed once and the values for the field amplitude obtained by interpolation.

Gaussian Quadrature

This is a well-known technique for carrying out numerical integration with a given accuracy and fewer grid points than those used in the evenly spaced grids. The grid points must be spaced unevenly to effect this improvement. A nonuniform weighting function is used. One possible penalty is the requirement for interpolation to obtain the field values at the proper locations in the source plane. In addition, for large Fresnel numbers, sampling restrictions lead to prohibitive run times.

Fast Fourier Transform

The FFT is a well-known technique [5] by which the number of steps required to carry out an integration of an $N \times N$-point 2-D function expanded in an $N \times N$ series of basis functions may be reduced from $\approx N^2$ to $\approx N \log_2 N$, which is a substantial saving when N is $\geqslant 100$. In its original version the FFT is suited to the case of a rectangular grid system. To carry out the procedure, one takes the (fast) Fourier transform of the field distribution in the source plane, propagates this transform to the observation plane with a simple multiplication, and finally, if desired, calculates the inverse (fast) finite Fourier transform.

Fast Hankel Transform

The FHT transform has been described by Siegman [6]. The Hankel transform and the Fourier transform are very closely related. In fact, the result of a zero*th* order Hankel transform is numerically equal to that of a double Fourier transform in x and y when the function being transformed is cylindrically symmetric. Higher order Hankel transforms accommodate cases where, for example, $\cos m\theta$ symmetries are present.

Gardner-Fresnel-Kirchhoff

The Gardner transform [7] is applied to Eq. (2), resulting in a Gardner-Fresnel-Kirchhoff (GFK) algorithm. If the Fresnel integral is written in terms of the cylindrical coordinate variables r and θ, the θ integrations can be carried out analytically for circularly symmetric fields. As it stands, the form of the remaining integral over γ does not lend itself to any of the fast transform techniques. However, if we apply the Gardner transform to the radial coordinate, the new variables u and u' appear in the form $(u - u')$, which is a form of a convolution to which the fast transform techniques can be applied. Both FHT and GFK methods use the Gardner transform. The FHT requires an additional Fourier transform, since a convolution is not used.

Strip Propagators

The strip propagator [8] is the appropriate one for the one-dimensional strip resonator problem in which the fields are independent of the coordinate along the strip. These propagators are applied in the annular region of circularly symmetric HSURIA resonators. Strip propagators are of interest because we anticipate great difficulty in handling the number of grid points required for a fully general treatment. We can understand these requirements from the following considerations. Let us imagine an annulus 60 cm in diameter with a 4-cm shell which is 400 cm long. From Eq. (3) we take the Fresnel number

$$N_F = \frac{2^2}{(3 \times 10^{-4})\,400} \approx 33 .$$

If we assume that the annulus can be considered as an infinite strip closed on itself, then about 500 points are required to properly model the field through the thickness. If now we add the possibility of an angular dependence around the annulus, we may require one to several orders of magnitude more points to model the fields properly, depending on the magnitude of the angular variations. A Fourier decomposition is made in the azimuthal components. These fields are then carried along separately.

Convergence

Convergence in laser resonators is an iterative process that amounts to reflecting the field around the resonator until the field distribution is repeated to within a multiplicative constant from one iteration to the next. This constant is related to the mode eigenvalue. The iterative procedure is terminated when the field stabilizes to within a convergence criterion. In some codes the measure of convergence is taken to be the (normalized) power in the field fed back into the resonator immediately after outcoupling. Convergence is reached when either (a) a certain number of the last computed values of the feedback power are all within some prescribed amount, or (b) the most recently computed minimum and maximum values of the feedback power agree to some preset number of decimal places. Convergence can also be established by requiring the point-to-point variation in the field distribution to be less than a prescribed amount for consecutive iterations.

When the two largest eigenvalues have nearly the same value, e.g., for resonators of nearly integer equivalent Fresnel number, convergence to the dominant eigenvalue can be quite slow if obtainable at all. In such situations convergence acceleration algorithms are sometimes used to predict the eigenvalue in hopes of reducing the number of iterations to convergence.* Since the results obtained with some algorithms can be misleading or erroneous, they should be utilized with caution.

Eigenvalue/Eigenvector Extraction [9]

In modern unstable resonator calculations, it is very important to determine a resonator's transverse mode behavior to ensure adequate transverse mode discrimination and insensitivity to small mirror misalignments (tilts, translations, decentrations, etc.). This means that, typically, several high-order transverse modes of the resonator, in addition to its lowest, need to be calculated. Ordinarily, however, numerical unstable resonator solutions yield only one eigenvalue, i.e., the one associated with the dominant, or lowest loss, mode represented by the stable (self-replicating) field distribution at convergence. Thus, to obtain information about some other (higher order) mode, one must somehow extract the known modes from the initial field distribution and reiterate the resonator to convergence. There are two basic problems with this approach. First, finding many eigenvalues (and transverse modes) one at a time for a complex resonator can be very expensive, since convergence must be reached every time. It would not be unusual for higher order modes to converge more slowly. Second, due to numerical inaccuracies, it could be very difficult to completely extract a known (lower order) eigenvalue from the starting field distribution, to prevent its dominating again after many iterations.

The Prony method, which provides an effective algorithm for extracting all of the significant lowest order modes in a resonator eigenvalue calculation, is one means of alleviating the problems just discussed [10]. Furthermore, with this method several different transverse modes of a resonator can be found without iterating the field to convergence! This is obviously a very powerful technique and provides an important measure of both power and efficiency to be considered in trading off resonator optics codes for use in higher order mode calculations.

Resonator Type

Standing-wave resonators have mirrors at either end of a cavity that reverse the beam direction, causing it to alternately retrace its path in the opposite direction. Field points inside standing-wave resonators have a bidirectional flux traveling through them. Traveling-wave resonators, commonly called ring resonators, circulate the mode unidirectionally (if properly designed). Sometimes, poorly designed traveling wave resonators can support reverse running modes, which are generally undesirable.

*For example, see Aitken's method as discussed in J. H. Wilkinson, *The Algebraic Eigenvalue Problem*, Oxford University Press, Cambridge, 1965, p. 578.

Branch

The branch of a resonator relates to the stability diagram [11] for two-element resonators, made up of spherical mirrors at unequal curvature (see Fig. IV-2), which is equivalent to a sequence of lenses of alternating focal length $f_1 = R_1/2$, $f_2 = R_2/2$ equally spaced a distance d apart.

One identical subelement of this sequence of lenses is a space d followed by a lens of focal length f_1, followed by another space d, and finally the second lens of focal length f_2. By applying the appropriate paraxial ray transfer matrix to this subelement and requiring that one-half the trace of this matrix be between -1 and 1, we arrive at the condition for stability. That is, for the optical system representing the complete round trip in the resonator mirror system, we have the equivalent lens sequence shown in Fig. IV-3.

The matrix operations are, for this sequence,

$$\begin{bmatrix} 1 & d \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \dfrac{-1}{f_1} & 1 \end{bmatrix} \begin{bmatrix} 1 & d \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \dfrac{-1}{f_2} & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 - d/f_2 & 2d - d^2/f_1 \\ -\dfrac{1}{f_1} - \dfrac{1}{f_2} + \dfrac{d}{f_1 f_2} & 1 - \dfrac{d}{f_1} - \dfrac{2d}{f_2} + \dfrac{d^2}{f_1 f_2} \end{bmatrix}.$$

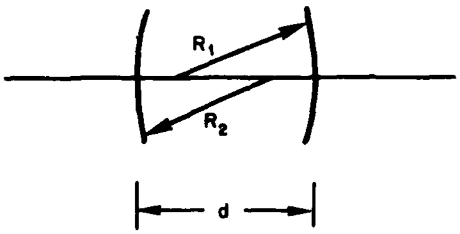


Fig. IV-2 — General open optical resonator

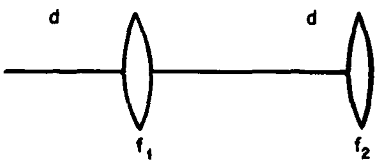


Fig. IV-3 — Equivalent lens sequence for open optical resonator

Stability requires that $-1 < 1/2(\text{trace}) < 1$, or,

$$-1 < 1/2 \left[2 - \frac{2d}{f_1} - \frac{2d}{f_2} + \frac{d^2}{f_1 f_2} \right] < 1 \, .$$

Thus,

$$0 < \left(1 - \frac{d}{R_1}\right) \left(1 - \frac{d}{R_2}\right) < 1 \qquad \text{for } \textit{stable resonators}$$

where we have substituted $f_1 = R_1/2$ and $f_2 = R_2/2$. Let $g_1 = 1 - d/R_1$ and $g_2 = 1 - d/R_2$. Then the unstable resonators split into two categories

$$\textit{positive branch} \qquad g_1 g_2 \geqslant 1$$

and

$$\textit{negative branch} \qquad g_1 g_2 \leqslant 0 \, .$$

The stability diagram is a plane representing all combinations of $g_1 g_2$, as in Fig. IV-4. A special case of great interest is the confocal resonator for which the focal points of the mirrors coincide. The condition of confocality is given by

$$f_1 + f_2 = d$$

which leads to contours of confocality

$$g_1 = g_2/(2g_2 - 1)$$

on the stability diagram.

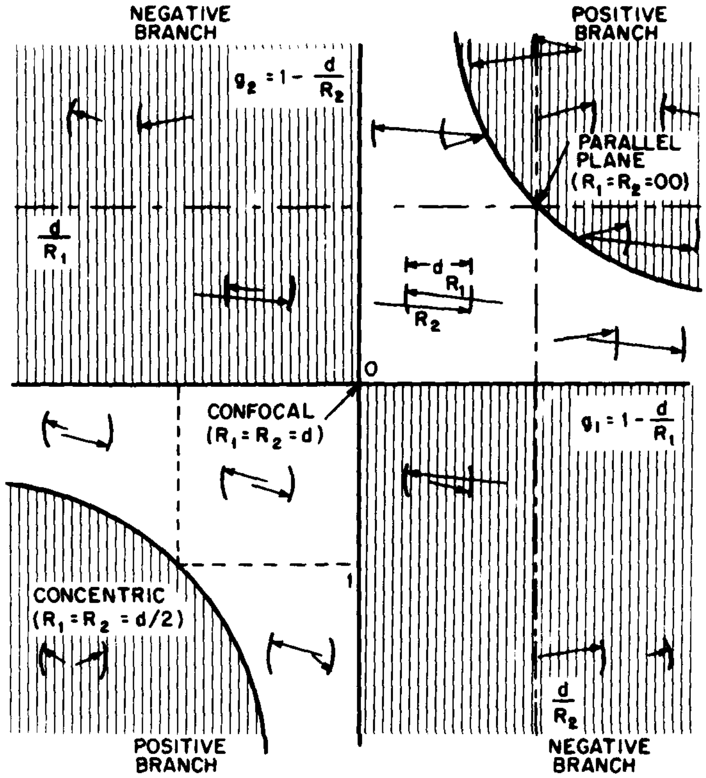
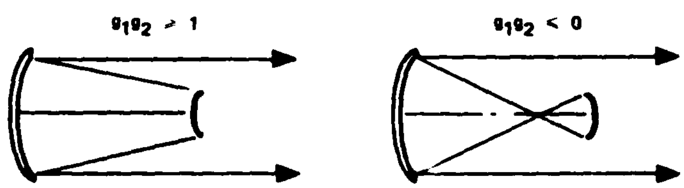


Fig. IV-4 — Stability diagram. Unstable resonator systems lie in shaded regions.

The *positive-branch confocal resonator* has g_1 and g_2 positive, but the curvatures of the mirrors are of opposite sign. The *negative-branch confocal resonator* has both curvatures positive, but g_1 and g_2 are of different sign. Thus, the negative-branch resonator has a real internal focus. These examples are shown in Fig. IV-5. Both have fundamental mode *collimated outputs.*



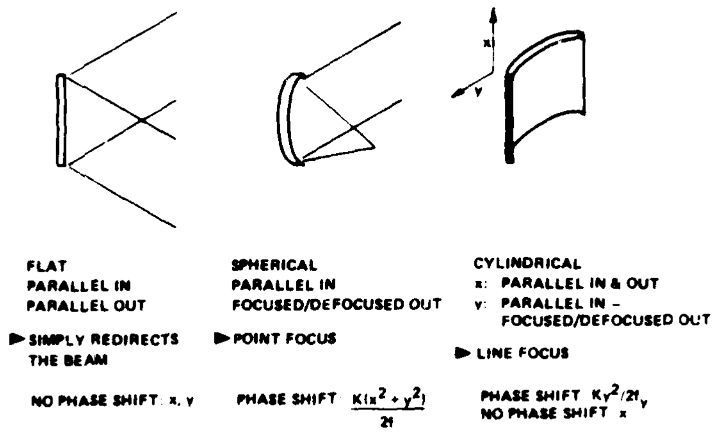
(a) Positive branch (b) Negative branch

Fig. IV-5 — Two classes of confocal resonator

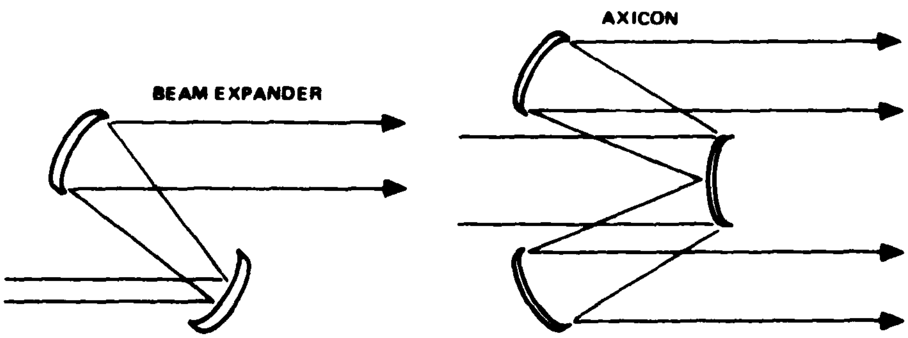
Optical Element Models Included

Most optics codes are capable of modeling standard components such as those discussed in this section.

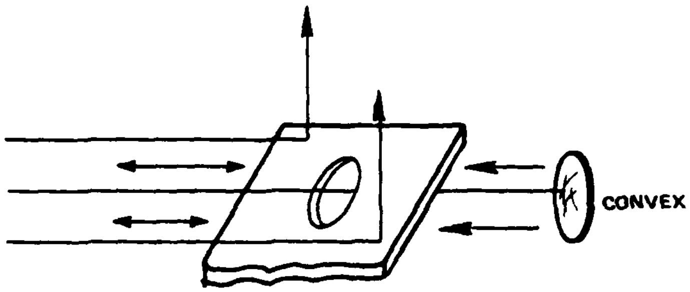
Flat, spherical, and cylindrical mirrors are standard optical components.



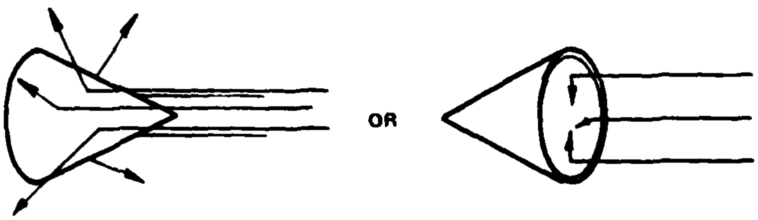
Telescopes, intra- or extracavity, are used to enlarge or reduce beam sizes.



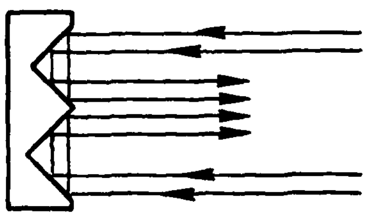
Scraper mirrors are placed between the end mirrors of unstable resonators to outcouple the beam. A scraper mirror is usually a flat with a hole in it, placed near the convex cavity mirror. (Note: Usually not modeled.)



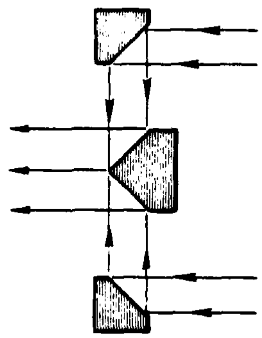
Axicon is the generic term for an axisymmetric, cone-shaped optical element.



Waxicon is the term for a compound axicon (two cones) whose cross section is W-shaped. An annular input beam is transformed into a compacted beam traveling in the opposite direction.



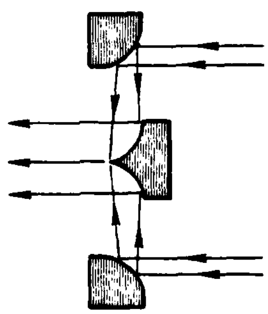
Reflaxicon refers to a compound axicon that compacts an annular beam without reversing the beam direction.



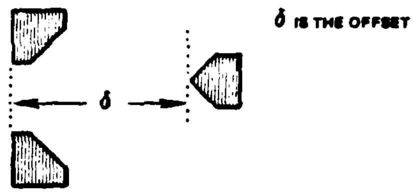
Arbitrary refers to the surface contour of the axicon. Arbitrary axicons can be designed to change the beam phase or intensity profiles.

Linear model: surface contour is a line of revolution, resulting in a true cone section.

Parabola-parabola model: the inner and outer cone of surfaces are parabolas of revolution. These configurations spread the compact beam to reduce flux loading on optical elements.



Variable cone offset is the axial separation between the inner and outer cones and is a code variable.



Deformable mirrors refers to a mirror whose surface contour is adjustable by use of a series of actuators. When a deformable mirror is coupled to a feedback system of sufficient bandwidth, an adaptive optic system results. This can be used to offset aberrations induced in the intracavity beam by gain media inhomogeneities and fluctuations, mirror deformations, or jitter.

Spatial filters refers to an aperture stop placed near a focal point to restrict passage of a beam to those elements that can be focused through the aperture. Since unwanted modes have energy in the wings of the focal pattern, the filter acts as a suppressant by removing this energy from the feedback loop. If the passage to a "point" focus is impossible due to high flux, then a cylindrical lens can be used to form a line focus, thereby spreading out the beam power over a greater area. In this case the filter is a line aperture.

Gratings are linear, circular, or holographic contours of wavelength dimensions etched or ruled into a mirror to disperse the beam.

Gain Models

Bare cavity models do not contain gain models but mathematically normalize the circulating flux to unity after each round trip. Simple saturated gain models use a simple gain algorithm for homogeneous and inhomogeneous broadening to boost the intracavity flux on each round trip. Detailed gain models calculate the gain by taking into account the actual number densities of active media at each field point and consider effects such as cascading, mixing, and deactivation. These models are summarized in the sections of the survey form dealing with kinetics (column 3) and gasdynamics (column 4).

Bare Cavity Field Modifier Models

Field modifiers are mathematical operations applied to the intracavity field at selected points to model various resonator elements such as mirrors or errors. For instance, errors due to thermal distortion of a laser mirror can be calculated once the field is predicted at

the plane of the mirror. An algorithm is then used to determine the mirror distortion, which in turn is converted to a phase error and added point by point to the field phase.

Recent work by Felsen, Dente, and others on the effect of the mirror edges on resonator mode stability and control have resulted in the comments on output coupler edges: rolled, serrated, etc.

Loaded Cavity Field Modifier Models

In loaded cavity models (gain included), field modifiers to simulate gain sheets as well as errors in the gain medium index of refraction, gaseous resonant or nonresonant absorption of the intracavity flux, or the effects of overlapped beams in detailed three-dimensional gain packages are sometimes modeled. The gain is a function of the laser intensity; hence, matrix methods are not usable, since the problem is nonlinear.

Far-Field Models

Far-field models are used to project a beam with a certain intensity and phase profile taken at the resonator output into the far field for purposes of evaluating beam quality. Errors in the output beam phase such as tilt and focus need to be removed in some instances in order to properly evaluate the residual beam quality. Beam quality is usually calculated by measuring the fraction of the total power that passes through an aperture of fixed size and comparing the ratio of the theoretically perfect beam to the predicted beam by one of a number of simple algorithms.

KINETICS

Introduction

The objective of the chemical kinetics subroutines in these computer codes is to calculate the gain coefficient by taking account of the detailed rates of pumping, deactivation, and stimulated emission of the vibrational states of the excited product molecules in the chemical reaction of the laser medium. These instantaneous point solutions are then coupled with fluid flow models (cf. discussion of column 4 of survey form) of various degrees of sophistication to describe the gain as a function of position transverse to the laser light beam propagating between the mirrors. Since the pumping and stimulated emission rates are dependent in part on the local intensity of laser light at the site of each molecule in the stream, one sees immediately that the most comprehensive solutions require that self-consistency be established (the laser light appears both as a cause and an effect of the molecular kinetics).

The *gain coefficient* α is calculated at a discrete plane along the propagation direction (z) and is used in the radiative transfer equation to calculate the local intensity I;

$$\frac{dI}{dz} = I\alpha .$$

The gain coefficient is derived from the details of the complex behavior of the molecules, which derives from functions of the following factors.

1. Their combustion formation processes (rate coefficients)

2. Collisions with other molecules (foreign and self-broadening and energy transfer)

3. Their motion at the temperature of the flowing, expanding gas (Doppler broadening)

4. Rotational and vibrational populations (Boltzmann or non-Boltzmann distribution plus partition function)

5. Einstein coefficients for stimulated emission and competing deactivation modes.

Gain Region Modeled

If the gain generator is in the compact region of an annular device, as it is in laboratory test beds in many cases, the model is appropriate for that configuration—that is, for example, linear banks of nozzle and parallel flow. If the gain generator is in the annular region, then cylindrical symmetry dictates a (r, θ) coordinate system to model the radial diverging gain medium.

Kinetics Grid Dimensionality and Symmetry

The molecular effects summarized above are calculated for each transverse point in the region intercepted by the laser beam modes in the most sophisticated models. For some geometries and flow patterns, an approximation of *one-dimensional kinetics* is assumed and implemented by averaging over the transverse coordinate perpendicular to the flow direction. The *variation of gain along the optic axis* is achieved by use of more than one transverse plane for the kinetics/gasdynamics calculation. One does so only with care, however, since this gain calculation can be very time consuming. Typically, one to three gain "sheets" are used, although some lasers have been studied with as many as six sheets. A rule of thumb is about one per meter of HF. One tries to keep the gain $\times$ length product between sheets such that the intensity rises linearly.

Chemical Reactions Modeled

The reactions modeled for use in high-energy lasers have generally fallen into three catetories: (a) cold, (b) hot, and (c) chain. *Cold* and *hot* are terms referring to the relative exothermicity of the one reaction compared with the other. The cold reactions are given by the class of halogen-hydrogen reactions

$$X + H_2 \rightarrow HX + H ,$$

where X is any of the halogen atoms F, Cl, Br, or I, and H can be replaced by D. The hot reactions are given by the class of atom transfer reactions,

$$H + X_2 \rightarrow HX + X .$$

The energy to be distributed among the reaction products is $-\Delta H + E_\alpha$ where ΔH is the change in enthalpy of the reaction and E_α is the activation energy needed to overcome the potential barrier between the two initially stable reactants. The reference to cold and hot reactions can be understood by reference to energy values for a specific reaction. For example,

$$F + H_2 \rightarrow HF^* + H$$

has

$$-\Delta H + E_\alpha = 34 \text{ kcal} ,$$

whereas

$$H + F_2 \rightarrow HF^* + F$$

has

$$-\Delta H + E_\alpha = 102 \text{ kcal} .$$

Since this excess energy appears as excited state HF^*, one sees that much higher vibrational levels are possible in the hot reaction.

The higher exothermicity of the hot reaction can be attributed to the difference between the very weak bonding of F_2 and strong dissociation energy at 0 kelvins from $v = 0$ of HF. The difference of about 100 kcal is sufficient to excite HF vibrationally to $v = 11$.

The *chain reaction* occurs with a mixture of H_2 and F_2 so that both the hot and cold reactions are present in the gain medium, supplying the necessary H and F atoms to activate the excited HF molecules. In addition, the hot reaction allows energetic interaction of F_2 with the excited HF above a minimum vibrational level to create a surplus of F atoms via the branch

$$HF^*(v \geqslant v_{min}) + F_2 \rightarrow HF(v = 0) + 2F .$$

The difference in exothermicity and hence in available vibrational energy for population inversion is clearly seen in the following coordinate energy level diagrams for F/H_2 and H/F_2 reactions. In Fig. IV-6 the energies shown are for one mole of reactants. The k_i' and k_i are the rate constants for activation and recombination, respectively.

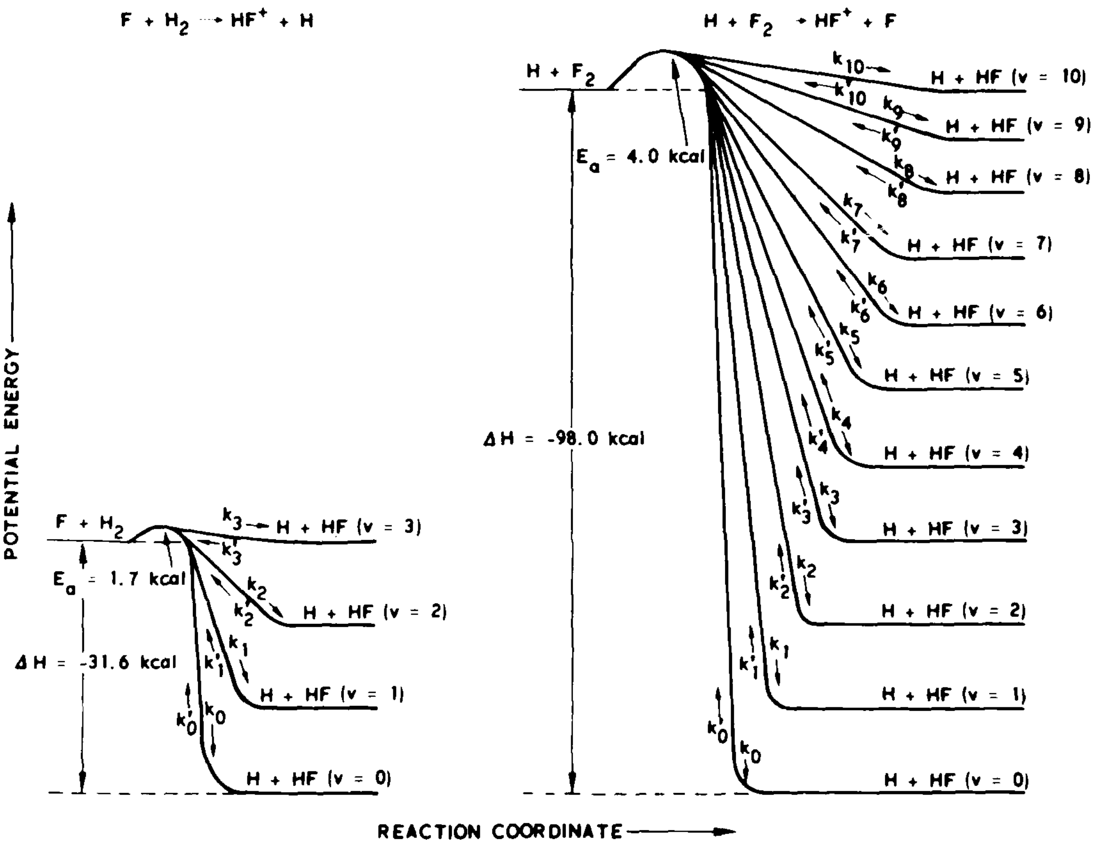


Fig. IV-6 — Reaction coordinate diagrams for F/H_2 and H/F_2 reactions [12a]

Modeling of Energy Transfer Modes

Deactivation of the inverted population occurs via stimulated emission together with competing radiative and collisional processes. Relaxation rate coefficients are used in the computer calculations to account for the self-deactivation of the hydrogen halides and for their deactivation by other species of atoms, molecules, and radicals present in the flowing medium.

The energy transfer occurs through either vibrational-translational reactions or vibrational-vibrational reactions. The vibrational-vibrational (rotational, V-$T(R)$) reactions are exemplified by

$$\mathrm{HX}(v) + \mathrm{M} \underset{}{\overset{k_{v,v-\Delta v}}{\rightleftarrows}} \mathrm{HX}(v - \Delta v) + \mathrm{M} + \Delta E(v,\Delta v)$$

where $k_{v,v-\Delta v}$ is the rate coefficient, v is the initial vibrational level of HX, and Δv is the number of vibrational quanta transferred to the chaperone specie molecule M as translational and/or rotational energy. This type of transfer leads, clearly, to a real loss of available quanta for stimulated emission at vibrational level v. In the vibrational-vibrational (v, v') reaction

$$\mathrm{HX}(v) + \mathrm{AB}(v') \overset{k_{v,v'}}{\rightleftarrows} \mathrm{HX}(v - \Delta v) + \mathrm{AB}(v + \Delta v) \ ,$$

energy remains in vibrational states. In the case of self-deactivation, lasing species are preserved in $v, - v'$ transfer.

Single vs Multiline

Since the vibrational-rotational levels are populated and deactivated at different rates, the inversion condition necessary for lasing depends on the instantaneous relative population between all *V-R* levels and therefore changes with time. Thus the spectral output of the chemical laser is generally *multiline.* The line profile as a function of the transverse flow coordinate is in general different for each line because of differences in gain distribution.

Rotational Population Distribution

To avoid excessive computational time, the assumption of rotational state population equilibrium is usually made. The partition function describes a Boltzmann distribution in this case. At the low pressures encountered in some HF laser designs, this assumption is not necessarily a good one. If, for example, collisional rates are greatly exceeded by stimulated emission rates, then the equilibrium assumption is suspect. Brute-force inclusion of rate equations for each J level would lead to inordinate run time and expense. Thus various simplifying assumptions are made, including empirical distributions fit to small-signal gain and chemiluminescence data. Care must be exercised, however, since in the absence of lasing, the Boltzmann distribution is very well fitted to available data.

Line Profile Models

The natural line width of the lasing transition is broadened by collision and the Doppler effect. In high-pressure devices (> 75 torr), collisional broadening dominates. In low-pressure devices (< 5 torr), Doppler broadening dominates. A convenient method for inclusion of both effects is to use the Voight function defined by

$$K(x,y) = \frac{y}{\pi} \int_{-\infty}^{\infty} \frac{e^{-t^2}\, dt}{y^2 + (x - t)^2} .$$

The line profile at wavenumber ω is then

$$\Phi(\omega; v,J,m) = \left(\frac{\ell n 2}{\pi} \right)^{1/2} \frac{1}{\alpha_{\mathrm{DP}}(v,J,m)} \quad K(x,y)$$

where

$$\int_{\omega_{c-\infty}}^{\omega_{c+\infty}} \Phi(\omega)\, d\omega = 1$$

$$x = (\ell n\ 2)^{1/2} \frac{|\omega - \omega_c(v,J,m)|}{\alpha_{\mathrm{DP}}(v,J,m)}$$

$$y = (\ell n\ 2)^{1/2} \frac{\alpha_{\mathrm{LR}}(v,J)}{\alpha_{\mathrm{DP}}(v,J,m)} .$$

Also, α_{DP} and α_{LR} are the Doppler and Lorentz HWHM (half widths at half maximum), respectively. For laser operation at line center ($\omega = \omega_c$), $x = 0$ and the Voight function [12b] reduces to the exact formula

$$K(0,y) = \left[1 - \mathrm{erf}(y) \right] \exp(y^2) .$$

Then in the limit of pure Doppler broadening ($y = 0$ and $K(0,0) = 1$), the line profile becomes

$$\Phi_{\mathrm{DP}}(\omega_c) = \frac{(\ell n\, 2/\pi)^{1/2}}{\alpha_{\mathrm{DP}}} ,$$

whereas in the (Lorentz) limit of pure collisional broadening ($y \to \infty$ and $K(0,y) \approx 1/y\sqrt{\pi}$ it becomes

$$\Phi_{\mathrm{LR}}(\omega_c) = \frac{1}{\pi \alpha_{\mathrm{LR}}}$$

For operation at other than line center ($\omega \neq \omega_c$), approximate algebraic expressions for the Voight function exist [13].

GASDYNAMICS

Background

Gasdynamics, the fourth column on the detailed code survey form, describes the capability of the code to account for the fluid mechanical properties of the gases as they are mixed and transported through the laser and, in particular, to account for the effects of gas mixing on the production rate and spatial distribution of HF^* (or DF^*), which determine power production.

Nozzle Type and Geometry Modeled

There are basically two distinct overall nozzle bank geometries that define the shape of the gain region: cylindrical and rectangular. The specific nozzle elements themselves usually reflect geometries characteristic of subsonic or supersonic flows. There are many different types of chemical laser nozzles. The cylindrical, radially flowing nozzle banks produce a gain region of annular cross section as seen in Fig. IV-7. The gases flow radially outward and hence the streamlines diverge. Rectangular, linearly flowing nozzle banks (shown in Fig. IV-8) produce a gain region of rectangular cross section with parallel streamlines. In either geometry the flow is transverse to the optical beam path.

Coordinate System

The representation and calculation of fluid flow phenomena are usually simplified when the chosen coordinate system reflects the flow field geometry. It is often important to be aware of which coordinate system is used in a given code, expecially when that code is to be combined with another for extended calculations or when a code is being considered as a candidate for analyzing a problem of given geometry where the run time, cost, and/or accuracy should be compromised if the coordinate system and problem geometry were not the same.

Fluid Flow Grid Dimension

This section requests specification of the spatial dimensionality of the numerical fluid dynamics grid. The ability to accurately represent actual physical phenomena increases (as do the run time and cost) as fluid grid dimensionality is increased from one to say, three dimensions. Certain phenomena may actually require four dimensions, three spatial dimensions and time, in order to be modeled satisfactorily. Other phenomena may be adequately modeled by only a single spatial variable in a time-independent calculation. There may be no advantage at all in using a code with higher dimension capability than is required for a given analysis, although there are usually significant cost, run time, and job turnaround penalties.

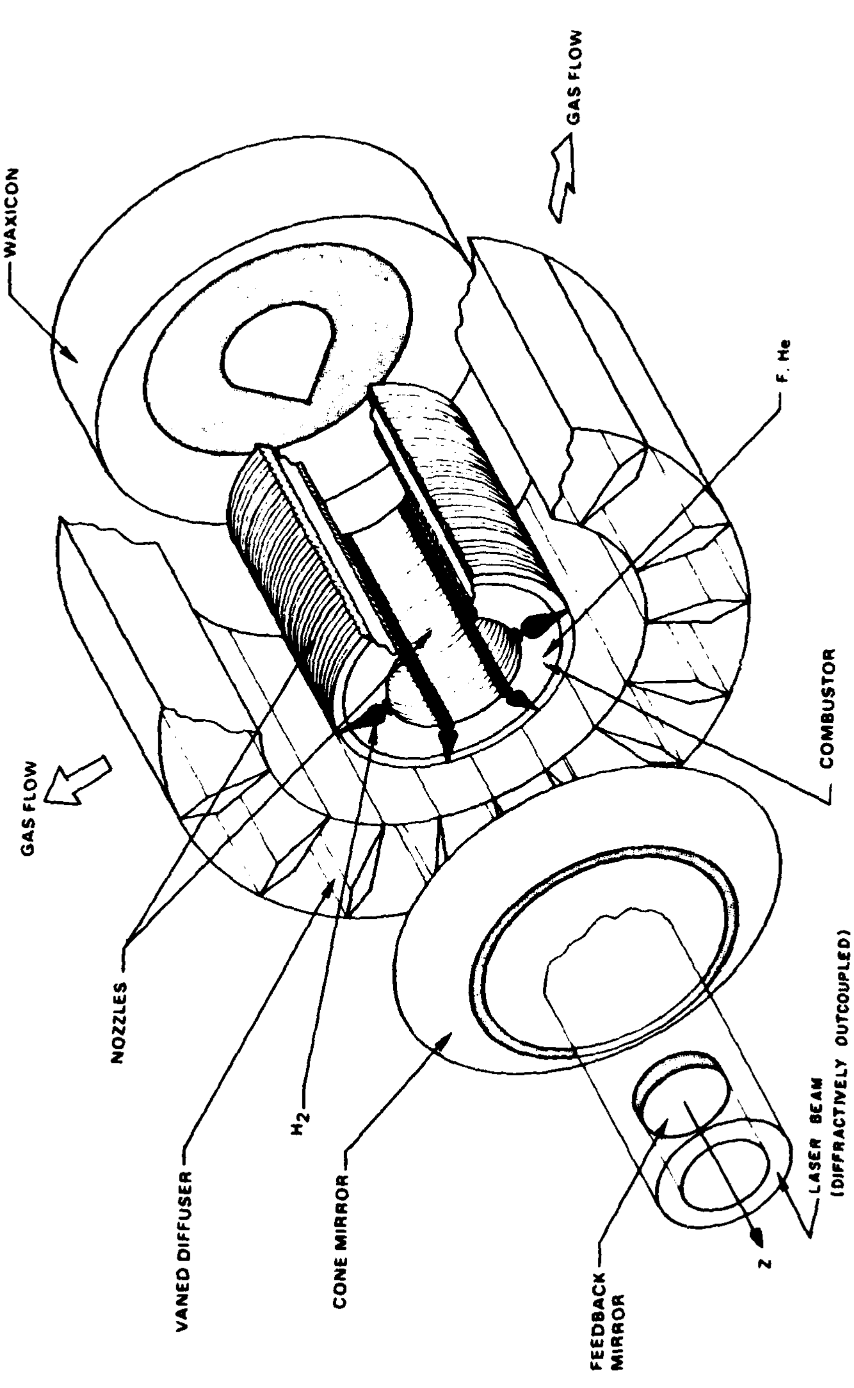


Fig. IV-7 — Hypothetical combustion-driven CW HF chemical laser employing a cylindrical, radially flowing nozzle bank and a HSURIA resonator producing an annular gain region

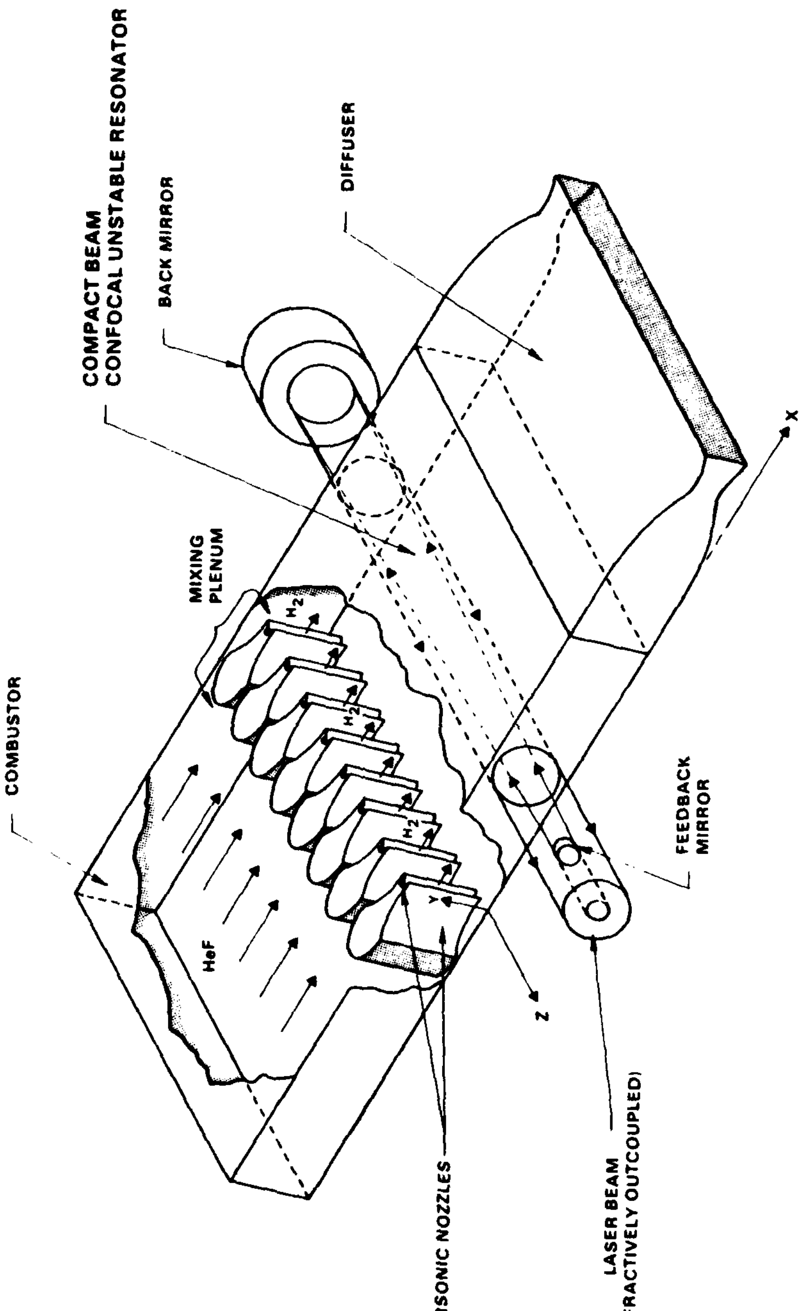


Fig. IV-8 — Hypothetical combustion-driven CW HF chemical laser employing a rectangular, linearly flowing nozzle bank and a positive-branch, compact-beam, confocal unstable resonator

Equally important (but ignored in the survey) in assessing the suitability of a code for a given problem is the actual number of grid points per grid dimension allowed, which determines the maximum sizes of the arrays that can be handled by the computer, and which for a given set of geometrical dimensions determines the maximum achievable resolution.

Flow Field Modeled

Typically the supersonic HF/DF mixing laser must solve a number of gasdynamical problems because the type of mixing influences the mixing rate that affects the lasing process. The mixing rate depends on whether the mixing in the laser cavity is laminar, transitional, or turbulent. Since this is a question that has not been fully resolved, the capability of a code for modeling a variety of flow field conditions is an important measure of its usefulness in certain types of performance analyses.

Basic Modeling Approach

When F and (H_2 of D_2) are mixed in a flowing system, the chemical reaction producing HF* (or DF*) begins as soon as the reactants come into contact. As a result the overall rate and spatial distribution of HF^* (or DF^*) produced by such a reaction is governed by both the chemical reaction rate and by the rate of mixing. Attempts to model the influence of both rates on power production and distribution in the cavity lead first to an investigation of two limiting cases, the so-called premixed and mixing- or diffusion-rate dominated cases.

In the premixed approach the rate of mixing or diffusion of F and H_2 is considered to be very fast compared to the reaction rate, and therefore the production of HF^* is limited by the chemical reaction rate. In this case gases are allowed to mix before the chemical reaction starts, hence the production of HF^* (and laser gain) occurs downstream from the mixing. Thus, in this limiting case the diffusion equations that describe the mixing process are ignored. This approach also leads to a considerable simplification in modeling.

In the mixing-rate-dominated approach, the rate of mixing (or diffusion) is considered to be slow in comparison to the chemical reaction rate, and therefore power production is governed by the mixing process.

As might be expected, neither limiting case is considered sufficiently accurate for modeling the coupling of finite diffusion and chemical reaction rates necessary for adequately describing HF production in CW HF lasers. As a result, other approaches have been developed that attempt a more realistic modeling approach, i.e., one that is intermediate between the limiting cases. For example, there is the so-called flame sheet solution approach. In this approach the mixing process is incorporated into the premixed solution through the use of a flame sheet diffusion profile [12]. Such approaches are referred to as scheduled mixing.

There are many approaches to modeling chemical lasers [12,14]. Generally they can be divided into two overall categories—those that are basically numerical and those that are analytical. Some of these are loosely grouped by category below in terms of (generally speaking) decreasing rigor, scope, and complexity:

Detailed Numerical Approaches

There are three main detailed numerical approaches, which are given here, with appropriate references.

- Rigorous attempts at mixing solutions (possibly with kinetic and radiative processes) included work by the following researchers:

A. W. Ratliff, J. Thoenes, and S. D. Smith, "Method of Characteristics Laser and Mixing Program Theory and User's Guide," vol. IV, Technical Report RK-CR-73-2, Lockheed Missiles and Space Co., Huntsville, Ala., 1973.

B. R. Bronfin, et al., "Development of Comprehensive Laser Computer Models," United Aircraft Research Laboratories Report K911252, Nov. 1971.

B. R. Bronfin, et al., "Development of Chemical Laser Computer Models," Air Force Weapons Laboratory Technical Report AFWL-TR-73-48, Kirtland AFB, July 1973.

"ALFA Code," Air Force Weapons Laboratory Technical Report AFWL-TR-78-19, Kirtland AFB, Feb. 1979. An upgrade of the LAMP code incorporating turbulent nozzle flows, cylindrical laser configurations, pressure-unbalanced cavity flows, effects of rotational nonequilibrium, and multiline lasing for analysis of CW chemical lasers.

"APACHE Code," Los Alamos Scientific Laboratory Report LA-7427, Jan. 1979. Time-dependent finite difference code for modeling a multicomponent chemically reactive fluid flow interacting with an intense radiation field.

D. B. Rensch and A. N. Chester, "Chemical Laser Mode Control Program," Final Technical Report, Contract DAAH01-70-C-1082, Hughes Research Laboratories, Malibu, Calif., 1971.

W. S. King and H. Mirels, "Numerical Study of a Diffusion Type Chemical Laser," *Amer. Inst. Aeronaut. Astronaut. J.* **10**, 1647 (Dec. 1972).

- Flame-sheet solutions incorporating mixing processes into premixed solutions through use of flame-sheet diffusion profile include those reported in "A Simplified Model of CW Diffusion-Type Chemical Laser," by H. Mirels, R. Hofland, and W. S. King, *Amer. Inst. Aeronaut. Astronaut. J.* **11**, 156 (1973).

- Premixed solutions (which ignore the diffusion equations which describe the mixing process) include the works of Emanuel, et al., and Meinzer, et al.:

G. Emanuel, W. D. Adams, and E. B. Turner, "RESALE-1: A Chemical Laser Computer Program," Aerospace Corporation Report TR-0172(2776)-1, El Segundo, Calif., 1972.

R. A. Meinzer, et al., "CW Combustion Mixing Chemical Laser: HF, DF," *Proceedings of the 6th International Quantum Electronics Conference*, Tokyo, Japan, Sept. 1970.

Approximate Analytical Approaches

- Variable gain-length mixing model:

J. E. Broadwell, "Effect of Mixing Rate on HF Chemical Laser Performance," *Appl. Opt.* 13, 962 (1974).

- Flame-sheet mixing scheme utilizing premixed solutions;

R. Hofland and H. Mirels, "Flame-Sheet Analysis of CW Diffusion-Type Chemical Lasers, I. Uncoupled Radiation," *Amer. Inst. Aeronaut. Astronaut. J.* 10, 420 (Apr. 1972).

H. Mirels and R. Hofland, "Flame-Sheet Analysis of CW Diffusion-Type Chemical Lasers, II. Coupled Radiation," *Amer. Inst. Aeronaut. Astronaut. J.* 10, 1271 (Oct. 1972).

H. Mirels, "Interaction Between Unstable Optical Resonator and CW Chemical Laser," *Amer. Inst. Aeronaut. Astronaut. J.* 13, 785 (June 1975).

J. M. Herbelin, "Continuous-Wave ($F + H_2$) Chemical Lasers: A Temperature-Dependent Analytical Diffusion Model," *Appl. Opt.* 15, 223 (Jan. 1976).

- Premixed solutions (which ignore diffusion):

G. Emanuel, "Analytical Model for a Continuous Chemical Laser," *J. Quant. Spectrosc. Radiat. Transfer* 11, 1481 (1971).

G. Emanuel and J. S. Whittier, "Closed-Form Solution to Rate Equations for an $F + H_2$ Laser Oscillator," *Appl. Opt.* 11, 2047 (1972).

Thermal Driver Modeled

The thermal driver refers to the process of generating the oxidizer, atomic fluorine, usually from F_2, SF_6, or NF_3. There are a number of different types of thermal drivers including arc heaters, shock tubes, resistance heaters, combustors, and chemical reactions. Whatever the method, it is necessary to produce a known, large concentration of F atoms with the thermal driver and then mix F with H_2 or D_2 in a fast expansion through a supersonic mixing nozzle. Figure IV-9 shows the role of the thermal driver in relation to mixing, population inversion, and pressure recovery. In the figure a combustor illustrates the production of atomic fluorine by burning nitrogen trifluoride in ethylene. It is important to accurately control the desired degree of fluorine dissociation, mass flow, and temperature of the F atoms since these quantities directly affect the laser operating point (defined by the combustor and nozzle diluent ratios β_c/β_n and mass flux $\dot{m}/A$), and hence the power production.

F-Atom Dissociation From:

Specifies the compound (F_2, SF_6, NF_3, etc.) from which atomic fluorine is obtained as modeled by the code. (See *Thermal Driver Modeled.*)

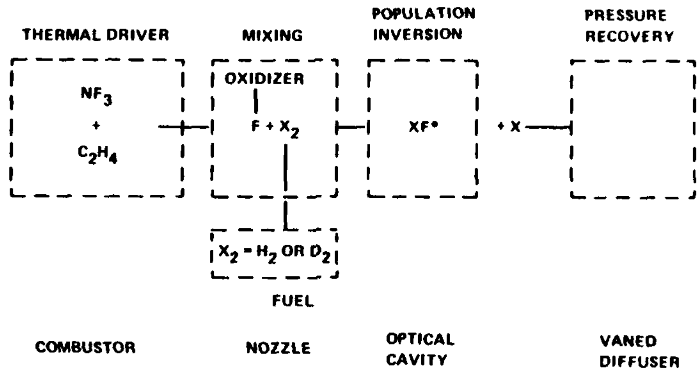


Fig. IV-9 — A CW mixing Hf/DF chemical laser illustrating use of a combustor as thermal driver

F-Atom Concentration Determined From Model?:

This question is posed to help determine the extent of computer model capability.

Diluents Modeled

Diluents (He, N_2, etc.) added to the mixing plenum play a very important role in establishing the laser operating point and hence the amount of power produced under a given set of conditions. It is of interest in measuring the capability of a computer model to determine the types of diluents and the extent to which their effect on laser performance is modeled. Often one may want to conduct tradeoff studies with several different diluents and/or diluent ratios as functions of other device parameters to optimize power output.

Models Effects on Mixing Rate Due To:

In the supersonic HF mixing laser there are many gasdynamical phenomena that will affect the mixing rate (and hence the detailed gain profile and power production). Thick laminar boundary layers of F and He can form along a nozzle wall and have a tendency to separate, giving rise to shock waves that can intersect in the flow outside of the nozzle. In assessing code capabilities it is important to determine whether such models are included.

Models' Effects on Optical Modes Due To:

Effects producing gain medium inhomogeneity arising from pressure, density, or refractive index variations can couple to and alter optical modes. Sonic or ultrasonic waves traveling in the active medium may cause these mode/media interactions.

REFERENCES

1. J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, New York, 1968, p. 40.
2. P. Horowitz, "Asymptotic Theory of Unstable Resonator Modes," *J. Opt. Soc. Amer.* **63**, 1528-1542 (1973).
3. R. R. Butts and P. V. Avizonis, "Asymptotic Analysis of Unstable Resonators With Circular Mirrors," *J. Opt. Soc. Amer.* **68**, 1071-1076 (1978).
4. J. Ellinwood and F. Meyer, Aerospace Corporation, private communication, 1980.
5. For example, see E. A. Sziklas and A. E. Siegman, *Appl. Optic.* 14, 1874 (Aug. 1975).
6. A. E. Siegman, "Quasi-Fast Hankel Transform," *Optics Lett.* 1, 13 (July 1977).
7. W. D. Murphy and M. L. Bernabe, "Numerical Procedures for Solving Nonsymmetric Eigenvalue Problems Associated with Optical Resonators," *Appl. Opt.* 17, 2359 (Aug. 1978).
8. A. G. Fox and T. Li, "Resonant Modes in a Maser Interferometer," *Bell Syst. Tech. J.* **40**, 453 (1961).
9. W. P. Latham, Jr., and G. C. Dente, "Matrix Methods for Bare Resonator Eigenvalue Analysis," *Appl. Opt.* 19, 1618 (1980).
10. A. E. Siegman and H. Y. Miller, "Unstable Optical Resonator Loss Calculations Using the Prony Method," *Appl. Opt.* 9, 2729 (Dec. 1970). Also, W. D. Murphy and M. L. Bernabe, "Numerical Procedures for Solving Nonsymmetric Eigenvalue Problems Associated with Optical Resonators," *Appl. Opt.* 17, 2359 (1978).
11. A. E. Siegman, *An Introduction to Lasers and Masers*, McGraw-Hill, New York, 1971, Chapter 8. See also, A. E. Siegman, "A Canonical Formulation for Analyzing Multi-element Unstable Resonators," *IEEE Trans.* QE 1[illegible] (1976).
12. R. W. F. Gross and J. F. Bott, eds., *Handbook of Chemical Lasers*, John Wiley & Sons, New York, 1976.

    a. p. 398
    b. p. 488

13. E. E. Whiting, *J. Quantum Spectrosc. Radiat. Transfer* 8, 1379 (1968).
14. J. M. Herbelin, *Appl. Opt.* 15, 223 (Jan. 1976).

BIBLIOGRAPHY

The following references are intended for users of this document who may not be familiar with one or more areas addressed by the survey or who may want a more detailed introduction to the subject. This list is not intended to be exhaustive; it does not contain references to numerous important papers.

R. W. F. Gross and J. F. Bott, eds., *Handbook of Chemical Lasers*, Wiley, New York, 1976.
This represents probably the best comprehensive review of chemical lasers. Individual chapters have been written by leaders of their respective areas of technology.

K. Smith and R. M. Thomson, *Computer Modeling of Gas Lasers*, Plenum Press, New York, 1978.
Although this text addresses primarily CO_2 laser chemistry, it is a good example of the breadth and level of detail achievable in modeling gas lasers.

A. E. Siegman, *An Introduction to Lasers and Masers*, McGraw-Hill, New York, 1971.
This introductory text covers the fundamental physics of lasers. Chapter 8 gives a good introduction to the theory of stable resonators.

J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, New York, 1968.
Material presented here is fundamental to modern diffraction and propagation algorithms.

J. D. Anderson, *Gasdynamic Lasers: An Introduction*, Academic Press, New York, 1976.
Comprehensive discussion of CO_2 gasdynamic lasers technology, developed from first principles.

S. Jacobs, M. Sargent III, and M. O. Scully, eds., *High Energy Lasers and Their Applications*, Addison-Wesley, Reading, Mass., 1974.
Chapter 5 by P. V. Avizonis reviews CO_2 electrical, CO_2 gasdynamic, and HF chemical lasers.

Appendix A
CHEMICAL LASER CODE CAPABILITY SURVEY FORM

1.0 OPTICAL CAVITY CODE

1.1 GENERAL (Please complete if different from 2.1 and 3.1)

CODE NAME: ______________________________

PROGRAM NAME (if applicable): ______________________________

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: ______________________________

____

____

____

____

____

ASSESSMENT OF CAPABILITIES: ______________________________

____

____

____

____

ASSESSMENT OF LIMITATIONS: ______________________________

____

____

____

____

ORIGINATOR/KEY CONTACT:

Name: ______________________________

Organization: ______________________________

Address: ______________________________

Phone: ______________________________

AVAILABLE DOCUMENTATION:

Theory Manuals: ______________________________

____

____

User Manuals: ______________________________

____

____

Listings: ______________________________

____

Other Relevant Publications: ______________________________

____

____

STATUS:

Operational Currently?: ____________

Under Modification?: ____________

Purpose(s): ______________________________

____

____

Ownership?: ______________________________

Proprietary?: ______________________________

MACHINE/OPERATING SYSTEM (on which installed): ____________

____

TRANSPORTABLE?: ____________

Machine Dependent Restrictions: ______________________________

____

SELF-CONTAINED?:

Other Codes Required (name, purpose): ______________________________

____

____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: ______________________________

1.2 CODE STRUCTURE

BASIC TYPE (√):

Physical Optics: ______________

Geometrical: ______________

FIELD (POLARIZATION) REPRESENTATION (√):

Scalar: ______________

Vector: ______________

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region: ______________

Annular Region: ______________

TRANSVERSE GRID DIMENSIONALITY (√):

	1-D	2-D
Compact Region:		
Annular Region:		

FIELD SYMMETRY RESTRICTIONS?: ______________

MIRROR SHAPE(S) ALLOWED (√):

Square: ______________

Rectangular: ______________

Circular: ______________

Elliptical: ______________

Strip: ______________

Arbitrary: ______________

CONFIGURATION FLEXIBILITY (√):

Fixed, Single Resonator Geometry: ______________

Fixed, Multiple Resonator Geometries: ______________

Modular, Multiple Resonator Geometries: ______________

Other (describe): ______________

____

____

PROPAGATION TECHNIQUE (√ all that apply):	COMPACT	ANNULAR
Fresnel Integral Algorithms:		
With Kernel Averaging:		
Gaussian Quadrature:		
Midpoint Rule:		
Romberg:		
Simpson:		
Trapezoidal:		
Fast Fourier Transform (FFT):		
Fast Hankel Transform (FHT):		
Gardener-Fresnel-Kirchhoff (GFK):		

Other (specify): ______________________________

Finite Difference Algorithms

Method (specify): ______________________________

____

CONVERGENCE (√):

Technique:

Power Comparison: ____________

Field Comparison: ____________

Other (specify): ______________________________

Acceleration Algorithms Used?: ____________

Technique: ______________________________

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (√):

Prony: ____________

Other (specify): ______________________________

____

1.3 RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

Stability (√):

Stable Resonators: ____________

Unstable Resonators: ____________

Type (√)

Standing Wave: ____________

Traveling Wave (Ring): ____________

Reverse Traveling Wave: ____________

Branch (√):

Positive: ____________

Negative: ____________

Optical Element Models Included (√):

Flat Mirrors: ____________

Spherical Mirrors: ____________

Cylindrical Mirrors: ____________

Telescopes: ____________

Scraper Mirrors: ____________

Axicons	Waxicons	Reflaxicons
Arbitrary:		
Linear:		
Parabola-Parabola:		
With Offset Cones:		
Other (specify):		

Deformable Mirrors: ____________

Spatial Filters: ____________

Gratings (specify type): ____________

Other Elements (specify): ____________

PRINCIPAL RESONATOR GEOMETRIES MODELED(e.g. HSURIA, Compact Unstable Confocal, Unstable P-P Waxicon/Linear Waxicon Negative Branch Ring With Spatial Filter, etc; Please List): ____________

GAIN MODELS (√):

Bare Cavity Only: ____________

Simple Saturated Gain: ____________

Detailed Model (see 2.0 below): ____________

BARE CAVITY FIELD MODIFIER MODELS (√):

Mirror Tilt: ____________

Mirror Decentration: ____________

Aberrations/Thermal Distortion

Arbitrary: ____________

Selected (specify): ____________

Reflectivity Loss: ____________

Output Coupler Edges

Rolled: ____________

Serrated: ____________

Other: ____________

LOADED CAVITY FIELD MODIFIER MODELs (√):

Refractive Index Variation: ____________

Gas Absorption: ____________

Overlapped Beams (for flux updating): ____________

Number of overlaps Allowed: ____________

Other (see 2.0, 3.0): ____________

FAR FIELD MODELS (√):

Beam Steering Removal: ____________

Optimal Focal Search: ____________

Beam Quality: ____________

Atmospheric Propagation Effects: ____________

Other: ____________

OTHER UNIQUE FEATUES (e.g. Beam/Mode Rotation, Extra-Cavity Adaptive Optics, Multipath/Parasitic Effect, etc.)__________

2.0 KINETICS

2.1 GENERAL (Please complete if different from 1.1 and 3.1)

CODE NAME:__________

PROGRAM NAME (if applicable):__________

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE:__________

ASSESSMENT OF CAPABILITIES:__________

ASSESSMENT OF LIMITATIONS:__________

ORIGINATOR/KEY CONTACT:

Name:__________

Organization:__________

Address:__________

Phone:__________

AVAILABLE DOCUMENTATION:

Theory Manuals:__________

User Manuals:__________

Listings:__________

Other Relevant Publications:__________

STATUS:

Operational Currently?:__________

Under Modification?:__________

Purpose(s):__________

Ownership?:__________

Proprietary?:__________

MACHINE/OPERATING SYSTEM (on which installed):__________

TRANSPORTABLE?:__________

Machine Dependent Restrictions:__________

SELF-CONTAINED?:__________

Other Codes Required (name, purpose):__________

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: ____________

2.2 CODE STRUCTURE/FEATURES

GAIN REGION (√):

Compact Region: ____________

Annular Region: ____________

COORDINATE SYSTEM (Cartesian, cylindrical, etc.)

Compact Region: ____________

Annular Region: ____________

KINETICS GRID DIMENSIONALITY (√)	1-D	2-D	3-D
Compact Region:			
Annular Region:			

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along

Optic Axis?: ____________

Flow Direction?: ____________

KINETICS TYPE MODELED (√):

Pulsed: ____________

CW: ____________

CHEMICAL PUMPING REACTIONS MODELED (√):

	X=F	X=D
Cold Reaction ($X+H_2$):		
Hot Reaction ($H+X_2$):		
Chain Reaction ($X+H_2$ and $H+X_2$):		

Other (including non-chemical, specify): ____________

____

ENERGY TRANSFER MODES MODELED (√): Follows (reference)

V-T: ______ | ______

V-R: ______ | ______

V-V: ______ | ______

Other (Specify): ______

Single Line Model (√): ______

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ______

Non-Equilibrium: ______

Number of Laser Lines Modeled: ______

Source of Rate Coefficients Used in Code: ______

______

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ______

Other (specify): ______

______

2.3 OTHER UNIQUE FEATURES: ______

3.0 GAS DYNAMICS

3.1 GENERAL (Please complete if different from 1.1 and 2.1)

CODE NAME: ______________________________

PROGRAM NAME (if applicable): ______________________________

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: ______________________________

____

____

____

____

____

ASSESSMENT OF CAPABILITIES: ______________________________

____

____

____

____

ASSESSMENT OF LIMITATIONS: ______________________________

____

____

____

____

ORIGINATOR/KEY CONTACT:

Name: ______________________________

Organization: ______________________________

Address: ______________________________

Phone: ______________________________

AVAILABLE DOCUMENTATION:

Theory Manuals: ______________________________

____

____

User Manuals: ______________________________

____

____

Listings: ______________________________

____

Other Relevant Publications: ______________________________

____

____

STATUS:

Operational Currently?: ____________

Under Modification?: ____________

Purpose(s): ______________________________

____

____

Ownership?: ______________________________

Proprietary?: ______________________________

MACHINE/OPERATING SYSTEM (on which installed): ______________________________

____

TRANSPORTABLE?: ____________

Machine Dependent Restrictions: ______________________________

____

____

SELF-CONTAINED?: ____________

Other Codes Required (name, purpose): ______________________________

____

____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (Sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: ______________________________

3.2 CODE STRUCTURE/FEATURES

COORDINATE SYSTEM (Cartesian, cylindrical, etc.):____________

NOZZLE GEOMETRY MODELED (√) (and nozzle type(s) if known):

Cylindrical-radially flowing:____________

Rectangular-linearly flowing:____________

Other (specify):____________

FLUID GRID DIMENSIONALITY (√):

1-D: ________

2-D: ________

3-D: ________

FLOW FIELD MODELED (√):

Laminar: ________

Turbulent:________

Other: ____________

BASIC MODELING APPROACH (√):

Premixed:____________

Mixing:____________

Other (specify):____________

References for Approach used:____________

THERMAL DRIVER MODELED (√):

Arc Heater: ________

Combustor: ________

Shock Tube: ________

Resistance Heater:________

Other (specify):____________

F-ATOM DISSOCIATION FROM

F_2: ________________

SF_6: ________________

Other (specify): ____

IS F-ATOM CONCENTRATION DETERMINED BY MODEL?: ________________

DILUENT(S) MODELED (list): ____

____

MODEL EFFECTS ON MIXING RATE DUE TO (√):

Nozzle Boundary Layers?: ____________________

Shock Waves?: ____________________

Pre-Reaction (thermal blockage, etc.)?: ____________________

Turbulence?: ____________________

Other (specify): ____

____

____

MODEL EFFECTS ON OPTICAL MODES DUE TO (√):

Index of refraction variation?: ______________________

Other (specify)?: ____

____

____

____

3.3 OTHER UNIQUE FEATURES: ____

____

____

____

____

____

____

____

____

____

Appendix B
RESEARCHERS AND SURVEY MAILING LIST

POTENTIAL MAILING LIST FOR CODE SURVEY

Novel Resonator Program Contractors

TRW

*L. L. Bullock (1), (2), (4)	ALL HEL codes and models; Gain model, ring resonator, optical rotator; IMOPA, BLAZER, MRO, CROQ, BRIA, URINLA2
K. T. Yano (1), (2), (4)	IMOPA, ring resonator, optical rotator, BRIA
J. B. Kaelberer (2)	IMOPA
D. Dee (2)	BLAZER, MRO
*H. W. Behrens (2)	BLAZER, MRO
C. L. Merkle (2) T. Sugimura (2) R. D. Hughes (2)	Monte Carlo laser flow, ALFA, LAMBDA nozzle, HYWND. Modeled chemical laser (CL) flow-thru nozzles; modeled recirculating flow regions and fuel/oxidizer stream merging.
R. S. Lipkis (2)	Gain modeling, saturation effects, hole burning, mode pulling.
H. M. Bobitch (2) J. Munch (2) A. Murthy (2)	Ring resonator with optical rotator (BRIA). Used double waxicon setup and evaluated mode control by measuring beam quality (BQ).
R. K. Delong (2)	MIRACL performance
P. M. Livingston (2), (4)	Doppler shift produced by HYWND
S. Jarvis (3)	
J. Miller (4)	
O. Minnick (4)	
K. Vogelsang (5)	

(1) Attendees, Novel Resonator Mid-Term Review, December 5 and 6, 1978, NRL.
(2) Attendees/Presenters, 6th Tri-Service Chemical Laser Symposium, August 28-30, 1979, AFWL.

*Survey recipient

(3) Attendees, ICAO/IFLA Review, April 10, 1979, AFWL.
(4) Distribution List for Novel Resonators for High Power Chemical Lasers Program.
(5) ADABECS Technical Interchange Meeting, September 12-14, 1979.

Rocketdyne

*R. Brandewie (1), (2), (4), (5)	(All codes and models)	Physical optics codes; geometrical optics code (GOPWA)
J. B. Shellan (1), (4), (5)		HSURIA performance analysis
G. A. Tyler (1), (5)		Ring resonators with spatial filters
T. Waite (1), (2), (3), (4) *D. Holmes (2), (3) P. Briggs (2)		Mode-media interactions in HSURIA with flowing gain model
G. E. Mevers (5)	(All codes and models)	Resonator configurations, alignment
F. D. Feiock (3), (5)	(All codes and models)	Resonator configurations, alignment
T. Marks (4)		
V. L. Gamiz (5)		Compensatory misalignment in ring resonators

Pratt & Whitney/United Technologies Research Center

Pratt & Whitney

P. E. Fileger (2) W. B. Watkins (2)	Anchored CLOQ3D kinetics model to CL-XI nozzle data as part of IFLA annular ring study.
*R. Quinnell (2), (3)	Used ALFA tilt sensitivity, IFLA rings, injection-locked annular resonator
R. Schmidtke (4)	
R. Freeman (4)	
*J. Campbell (3), (4)	
J. M. Bruckler (3)	
G. MacClafferty (4)	

*Survey recipient

UTRC	
R. L. Hall (2) H. R. Garcia (2), (3), (4)	CLOQ3D studies using ALFA code of mixing regions; rotational nonequilibrium; wave optics. Garcia only: Injection-locked annular resonator.
P. Slaymaker (2) R. Tansey (2) K. E. Oughstun (2), (3)	Tilt misalignment sensitivity studies on unstable negative-branch ring resonators (IFLA). Forward/reverse mode sensitivity studies.
A. W. Angelbeck (2) G. E. Palma	Analysis and computer modeling of injection-locked annular resonator. Also compact rings. Geometrics and wave optics.
J. J. Hinchen (2) R. H. Hobbs (2)	Rotational relaxation and linewidths for DF compared to HF. Pressure broadening measurement.
J. M. Spinhirne (3)	
R. Freiberg (3)	
Perkin-Elmer	
*P. B. Mumola (1), (2), (4) D. Stoler (1), (2)	Mode selectivity in annular resonators, radial strut effects on mode control. HSURIA comparison.
P. W. Milonni (2)	Anomalous dispersion in HF/DF. Broadening.
F. Way (4)	

Non-NOVEL Resonator Program Contractors

Bell Aerospace	
W. Brandkamp (1), (4)	
T. F. Buddenhagen (1), (3)	
*S. W. Zelanzy (2) W. A. Chambers (2), (3) M. Subbiah (2) L. Lang (2)	Extended BLAZE to STARE, a rotational equilibrium code modeling upstream-downstream coupling across optical axis. Compares with CL-XI nozzle data.

*Survey recipient

W. Solomon (4)	
W. L. Rushmore (2)	Efficient nonrotational equilibrium model
Aerospace Corporation	
*R. A. Chodzko (1), (2), (4) H. Mirels (1), (4) E. B. Turner (2) S. B. Mason (2)	Experimental HSURIA with linear waxicon and rear flat. Tip and outer cone obscuration studies, strut obscuration studies, polarization studies. HSURIA w/rear cone comparisons.
R. L. Varwig (2) P. L. Smith (2) C. P. Wang (2), (4)	Phase detectors based on optical heterodyning with acousto-optic modulator for control of adaptive optics. Anomalous dispersion studies.
C. G. Coffer (2) R. W. F. Gross (2)	Multiline HF tuning and phase control. Anomalous dispersion in HF.
J. F. Bott (2) R. F. Heidner (2)	Upper vibrational level deactivation in HF/DF. Absolute rate coefficient for $F + H_2$ and $F + D_2$. Oxygen-iodine laser; upper vibrational level deactivation in a HF/DF.
R. L. Wilkins (2) M. A. Kwok G. I. Segal (2) E. F. Cross (2) R. H. Ueunten (2)	Temperature dependence of vibrational relaxation from upper vibrational levels of HF and DF. V-R and V-V studies. Experimental study of significance of R-T equilibrium in presence of V-R collisional transfer.
*N. Cohen	Temperature dependence and rate coefficients for $F + H_2$, $F + D_2$, $H + F_2$, and $D + F_2$ pumping reactions.
*W. Warren (4)	
W. J. Schafer Associates	
*W. Evers (1), (2), (4)	
G. W. Zeiders (1), (2), (4)	
E. Gerry (4)	
R. Schaefer (2)	

*Survey recipient

Science Applications, Inc.

*F. Horrigan (Boston) (1), (4)	
J. Long (Atlanta) (1)	
*R. Wade (Atlanta) (1), (3), (4)	
S. S. Howie (Atlanta) (2) K. E. Patterson (Atlanta) (2)	Modeled gasdynamics of high area relief nozzles.
H. Ford (Atlanta) (4)	
*R. Hodder (Stuart) (4)	

MIT Lincoln Laboratory

*A. J. Morency (1), (2) R. Osgood (1), (2) *C. A. Primmerman (1), (2) R. Rediker (4) L. Marquet (4)	Modeled propagation of arbitrarily polarized electric fields via physical optics code.
*J. Herrman	

Air Force Weapons Laboratory

A. Paxton (1), (2), (3), (4)	HSURIA, rings, three-level cascading HF/DF media.
*W. Plummer (1), (3), (5)	All resonators and codes.
G. C. Dente (2)	Polarization effects in HSURIA with real cone.
R. Butts (3), (4), (5)	Atmospheric effects; thermal blooming.
T. Salvi (2), (4)	Physical optics codes, kinetics, and fluid dynamics.
L. D. Buelow (3)	
*B. Deuto (3)	
P. Latham (3)	Modular physical optics codes (MOC3).
R. F. Shea (2), (3)	Oxygen-iodine kinetics.
R. Bower (4)	

*Survey recipient

W. H. Lowrey (2) H. D. McIntire (2) W. H. Swantner (2)	Interferometric testing of waxicons and reflaxicons and aberration balancing using two geometric ray-tracing codes.
*N. L. Rapagnani	
The BDM Corporation	
*T. R. Ferguson (2), (3)	Physical optics codes URINLA2, GURDM, MOC3, PROPAGATORS.
G. T. Worth (2)	Physical optics codes GURDM, MOC3, intra/extra cavity adaptive optics.
*D. N. Mansell (2), (3), (4)	Geometric codes POLYPAGOS; IPAGOS, MCPPAGOS, IMOPA.
C. M. Wiggins (2), (5)	Physical optics codes HSURIA with rear flat, positive- and negative-branch ring resonator, spatial filtering, self-imaging (GENRING, SARAD).
Hughes Aircraft Company	
M. Greenfeld (3)	
*D. Fink (3), (4)	Optics.
*B. J. Skehan (4)	LPTS code.
J. Fitts (4)	
W. B. King	Beam Control Systems (LPTS code).
R. Cubalchini	Beam Control Systems (BREUX code).
*I. Abrahmowitz	
Ford Aerospace	
*V. F. Pizzurro (3), (5)	
P. Valliones (4)	
*R. Buchheim (5)	
GE Company/RESD	
*J. B. Gilstein (4)	

*Survey recipient

C. S. Draper Lab

J. Valge (4)

*C. Whitney (4)

AVCO Everett Research Labs

*J. Daugherty (4)

Johns Hopkins Applied Physics Laboratories

*R. Gorozdos (4)

Pacific Sierra Research

*A. Shapiro (4)

ITEK Corp.

*J. R. Vyce (4)

Lawrence Livermore Lab

*J. Emmett (4)

Lockheed Missile and Space Company

*R. Stewart (4)

Los Alamos Scientific Laboratory

*C. Fenstermacher (4)

J. Ramshaw (4)

McDonnel Douglas Astronautics

W. Gaubatz (4)

Director, Naval Research Laboratory

P. Ulrich (1), (4)

W. Watt (4)

S. C. Lin (1), (4)

---

*Survey recipient

L. Sica (1), (4)

W. C. Carter (1), (4)

L. Drummeter (4)

J. MacCallum (4)

J. Walsh (1)

Under Secretary of Defense (RE&S)

R. Airey (4)

Defense Advanced Research Projects Agency (Info)

A. Pike (1), (4)

*R. C. Sepucha (1)

U. S. Army Missile R&D Command (MIRCOM)

*C. J. Albers (1), (4)

*J. M. Walters (1)

Deputy Assistant Secretary of the Navy

T. A. Jacobs (4)

Office of Naval Research

W. Condell (4)

Naval Sea Systems Command

D. Finkleman (4)

*J. Stregack (4)

Rome Air Development Center

R. Ogrodnik (4)

---

*Survey recipient

Polytechnic Institute of New York

S. H. Cho (2) L. B. Felsen (2)	Circular mirror resonators with axicons modeled using ray optics; cone tip and edge diffraction studied.

University of Illinois

*L. H. Sentman (2) P. Bradbury (2)	Efficient rotational nonequilibrium model. V-R and V-V relaxation in HF and DF.

Sandia Laboratories

*J. B. Moreno (2)	HF chemical laser models for laser fusion.

Michigan State University

*R. L. Kerber (2) R. C. Brown (2) K. Emery (2)	Evaluation of rotational nonequilibrium models for R-R, and V-R transitions. Computer simulation.
D. H. Stone (2)	Developed statistical model to correlate relative rate coefficients in HF/DF pumping.

R&D Associates

J. M. Green (2) *R. D. Melville T. K. Tio (2)	Gas breakdown in CL resonators (HSURIA) with rear cone. Gas breakdown on line focus of axicons in presence of dirty helium.

*Survey recipient

FINAL MAILING LIST CODE SURVEY

Name and Phone	No. Cys.	Address
Dr. Don L. Bullock	5	TRW DSSG
213-535-3484		One Space Park
Dr. H. W. Behrens	3	Redondo Beach, CA 90278
Dr. R. A. Brandewie	5	Rocketdyne Division
213-884-3844		Rockwell International
Dr. Dale A. Holmes	3	6633 Canoga Avenue
213-884-3367		Canoga Park, CA 91304
Mr. Robert D. Quinnell	5	Pratt & Whitney Aircraft
305-840-4949		Government Products Division
Dr. Joseph L. Campbell	3	P.O. Box 2691
305-840-4173		West Palm Beach, FL 33402
Dr. H. Robert Garcia	5	United Technologies Research Center
305-840-1327		Optics & Applied Technology Lab
Dr. A. W. Angelbeck	3	P.O. Box 2691
		West Palm Beach, FL 33402
Dr. P. B. Mumola	5	The Perkin-Elmer Corporation
203-762-4415		Electro-Optical Division
		50 Danbury Road
		Wilton, CT 06897
Mr. S. W. Zelazny	3	Bell Aerospace Textron
716-297-1000		Division of Textron
		Buffalo, NY 14240
Dr. R. A. Chodzko	2	Aerospace Corporation
213-648-7390		2350 El Segundo Blvd.
Dr. N. Cohen	2	El Segundo, CA 90045
Dr. Walter R. Warren	2	
Dr. William Evers	2	W. J. Schafer Assoc.
703-525-6435		1901 N. Fort Myer Dr.
		Suite 803
		Arlington, VA 22209
Dr. Frank Horrigan	1	Science Applications, Inc.
617-275-2200		3 Preston Court
		Bedford, MA 01730

Dr. Richard Wade 404-955-2663	1	Science Applications, Inc. 6600 Powers Ferry Rd. Suite 220 Atlanta, GA 30339
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Mr. A. J. Morency 617-862-5500	2	Massachusetts Institute of Technology, Lincoln Laboratory
Dr. C. A. Primmerman	1	P.O. Box 73
Dr. Jan Herrman	1	Lexington, MA 02173
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Mr. B. Deuto 505-264-1704	2	Air Force Weapons Laboratory AFWL/LRE Kirtland AFB, NM 87117
Mr. N. L. Rapagnani	2	Air Force Weapons Laboratory AFWL/ALC Kirtland AFB, NM 87117
Dr. Thomas R. Ferguson 505-264-8568	5	The BDM Corporation 1801 Randolph Rd., S.E.
Mr. Dennis N. Mansell 505-843-7870	3	Albuquerque, NM 87106
Dr. David Fink 213-391-0711	3	Hughes Aircraft Company Centinela and Teale Streets
Dr. B. J. Skehan	2	Culver City, CA 90230
Dr. I. Abrahmowitz	2	
Mr. Vito F. Pizzurro 714-759-6679	2	Ford Aerospace/FACC Ford Road
Mr. Robert Buchheim	2	Newport Beach, CA 92663
Dr. Jack B. Gilstein	2	GE Company/RESD Advanced Laser Program Dept. 3198 Chestnut St. Philadelphia, PA 19101
Ms. C. Whitney	1	Charles Stark Draper Laboratory 555 Technology Square Cambridge, MA 02839

Dr. J. Daugherty	1	AVCO Everett Research Labs 2385 Revere Beach Parkway Everett, MA 02149
Dr. R. Gorozdos	1	Applied Physics Laboratory Johns Hopkins University Johns Hopkins Road Laurel, MD 20810
Dr. A. Shapiro	1	Pacific Sierra Research 1456 Cloverfield Blvd. Santa Monica, CA 90404
Mr. J. R. Vyce	1	ITEK Corporation Optical Systems Division 10 Maguire Road Lexington, VA 02173
Dr. J. Emmett	1	Lawrence Livermore Laboratory P.O. Box 808 Livermore, CA 94551
Mr. R. Stewart	4	Lockheed Missile & Space Co. Research & Development Division Sunnyvale, CA 94086
Dr. C. Fenstermacher	2	Los Alamos Scientific Laboratory L Division P.O. Box 1663 Los Alamos, NM 87554
Mr. William Gaubatz	1	McDonnell Douglas Astronautics Dept. 226, Mail Stop 14-1 5301 Bolsa Avenue Huntington Beach, CA 92647
*Dr. Peter B. Ulrich Code 6504, 202-767-3069	1	Naval Research Laboratory 4555 Overlook Avenue, S.W. Washington, DC 20375
*Dr. Sam C. Lin Code 6530, 202-767-3068	1	
*Dr. Alan Pike	1	Defense Advanced Research Projects Agency 1400 Wilson Blvd. Arlington, VA 22209
*Dr. R. C. Sepucha	1	

*Information copy only

*Dr. J. Stregack	1	Naval Sea Systems Command PMS/405-PM-22 Washington, DC 20362
*Mr. R. Ogrodnik	1	Rome Air Development Center Griffiss AFB, NY
Dr. L. B. Felsen 516-694-5500	2	Polytechnic Institute of New York Farmingdale, NY 11735
Dr. L. H. Sentman	2	University of Illinois Aeronautical & Astronautical Engineering Department Urbana, IL 61801
Dr. J. B. Moreno	3	Sandia Laboratories Laser Physics Research Division 4212 Kirtland AFB, NM 87117
Dr. R. L. Kerber	2	Michigan State University East Lansing, MI 48824
Dr. R. D. S. Melville, Jr.	2	R & D Associates P.O. Box 9695 Marina del Rey, CA 90291

Subtotal:	115
Extra:	20
Total	135

*Information copy only

Appendix C

BELL AEROSPACE CODES RESPONSE

This appendix contains two tables summarizing the analysis capability related to the Bell Aerospace Textron laser and reports detailed information on 28 codes. This information is provided as submitted by Bell Aerospace Corp.

Table C-1 — Laser Design Related Computer Analysis Capabilities at Bell

KEY FEATURES, METHODOLOGY, STATUS / CODE	1 BLAZE I (BELL)	2 BLAZE II (BELL)	3 BLAZE III (BELL)	4 BLAZE IV (BELL)	5 COMOC - 2DNS (BELL)	6 COMOC - 3DPNS (BELL)	7 COMOC - TA (BELL)	8 COMOC SA (BELL)	9 CNCDE (BELL)	10 DIFF-2 (BELL)	11 DIFF-3 (BELL)	12 NORO I (BELL)	13 NORO II (BELL)	14 ACCOS (SCI)	15 MRO-2 (TRW)	16 BLAZE V (BELL)	17 BLAZE VI (BELL)	18 R E OPTIC (BELL)
1 ANALYZE COMBUSTOR	●	●	●			●	●	●	●									
2. ANALYZE NOZZLE			●				●	●	●							●		
3 ANALYZE OPTICAL CAVITY	●	●	●	●	●	●			●			●	●		●			
4. ANALYZE OPTICS							●	●		●	●			●	●		●	●
5 ANALYZE DIFFUSER EJECTORS			●		●				●									
6 OPERATIONAL	●	●	●			●	●	●	●			●		●	●	●		
7 IN DEVELOPMENT				●	●					●	●		●				●	
8 MODIFYING FOR IBM 360																		
9. THREE DIMENSIONAL						●					●			●			●	
10 TWO DIMENSIONAL			●	●	●		●	●		●						●		
11 ONE DIMENSIONAL	●	●							●			●	●					
12 FLUID ANALYSIS	●	●	●	●	●	●			●				●			●	●	
13 STRUCTURAL ANALYSIS								●										
14. THERMAL ANALYSIS							●									●		
15 COMPUTES LASER POWER		●													●		●	
16 GENERAL CHEMISTRY	●	●	●	●									●				●	
17. PREMIXED	●	●							●									
18 SCHEDULED MIXING		●								●	●		●			●		
19. LAMINAR MIXING		●	●	●	●	●				●	●		●			●	●	
20 TURBULENT MIXING		●	●	●	●	●				●	●		●					
21 TURB.-CHEM INTERACTION		●	●	●	●	●				●	●		●					
22 20 N S. EQS																		
23 BOUNDARY LAYER EQS.			●			●										●		
24 PARABOLIC N S EQS				●														
25 FREE SHEAR LAYER ANALYSIS																		
26 METHOD OF CHARACTERISTICS																		
27. CONTROL VOLUME ANALYSIS									●									
28 FINITE ELEMENT					●	●	●	●								●		
29 FINITE DIFFERENCE																●	●	
30 EXPLICIT INTEGRATION					●	●	●	●										
31 IMPLICIT INTEGRATION	●	●															●	
32 EXPLICIT IMPLICIT			●	●												●		
33 FFT										●	●						●	
34 ROTATIONAL NON EQUIL												●	●				●	●
35 SIMPLIFIED CHEMISTRY					●	●						●			●			●
36 SIMPLIFIED FLUID MECH												●			●			●
37 FAB PEROT CAVITY		●										●	●					
38 UNSTABLE RESONATOR										●	●						●	●
39 COMPUTES ZERO POWER GAIN	●	●	●	●											●			
40 COMPUTES MEDIA QUALITY						●											●	
41 COMPUTES SPECTRAL DIST																	●	

Table C-2 — Bell Aerospace Codes

RESONATOR ANALYSIS CAPABILITY

FEATURES \ CODES	GOAD (1)	ARM-D (2)	ARM-G (3)
(1) OPERATIONAL ON IBM 370	X		X
(2) OPERATIONAL ON CYBER 176		☐	
(3) GEOMETRIC ANALYSIS	X		X
(4) DIFFRACTIVE ANALYSIS		X	
(5) r-X MODELED		X	
(6) r-θ-Z MODELED	X		X
(7) LOADED CAVITY		X	
(8) DIFFRACTIVELY COMPUTES FFBQ		☐	X
(9) MODELS HSURIA RESONATOR		X	X
(a) INTERNAL FOCUS WAXICON	X	X	X
(b) CONFOCAL REAR CONE		X	☐
(c) VTT ABERRATIONS	X		
(d) REFLAXICON		X	X
(10) MODELS RING RESONATOR		X	X
(11) MODELS STRUT EFFECTS			
(12) MODELS MISALIGNMENT AND TILT EFFECTS			X
(13) MODELS MIRROR THERMAL DIST.			
(14) MODELS MEDIA EFFECTS			

NOTES: (1) THE ARM-D CODE MODELS r-θ-Z IN COMPACTED LEG ONLY, SRM-D IS USED IN ANNULAR LEG.
(2) *DENOTES HAC SUPPLIED CODE CAPABILITY.
(3) CODE (3) PROVIDES SAME CAPABILITY, HOWEVER, ARM-G ALLOWS FOR INTERACTIVE MODE OPERATION DUE TO REDUCED CORE SIZE REQUIREMENT.
(4) ☐ DENOTES FEATURE CURRENTLY BEING INCORPORATED,
* DENOTES FEATURE NOT YET EXERCISED BUT WITH THE CAPABILITY FOR ANALYSIS CURRENTLY EXISTING.

DATE
ILME